

Theme Two

Ecosystems and Habitats

Thematic Issues

The remote location of the Arctic Ocean, Chukchi Sea, Bering Sea, Gulf of Alaska, and Southeast Alaska have left these waters relatively unexplored and not well-understood compared to other U.S. marine and coastal waters. There is a lack of understanding of marine ecosystems and habitats and how they may be affected by human activities, as dramatically demonstrated by the 1989 *Exxon Valdez* oil spill.

Commercial and recreational activities can disrupt marine, estuarine, and coastal watershed ecosystems. The disruptions can adversely affect people who rely on healthy ecosystems.

Human-generated debris exists in Alaska's oceans and rivers. It can injure or kill animals and can adversely affect ecosystem function. Marine debris can damage marine vessels.

Operation of boats, marine debris, oil spills, fishing gear entanglements, and military testing close to marine mammals and birds can adversely affect the animals' migration, breeding, and feeding behaviors, and ultimately their survival.

Nonindigenous marine organisms can disrupt and displace desirable native species, causing ecological and economic harm. Nonindigenous marine species have colonized Alaska waters, but little is known about their current and potential negative impacts. Inadequate controls are in place to prevent continued introduction of more nonindigenous species.

Goal

Maintain the ecosystem function of Alaska's important marine, estuarine, and coastal watershed habitats with a minimum of human-caused disruptions or negative impacts.

OBJECTIVE 1

Conduct research, education, and extension to provide greater understanding among Alaskans and those making policy decisions regarding the role and function of habitat in the marine, estuarine, and coastal watershed ecosystems.

Strategies

- Conduct research to identify methods to minimize negative effects of humancaused impacts on ecosystems, while developing restoration techniques applicable to marine, estuarine, and coastal watershed habitats.
- Conduct research to examine ecosystem and habitat resilience to changes in climate or marine, estuarine, and coastal watershed hazards; and develop risk vulnerability models for balancing resource use and conservation for decision makers.
- Conduct education and extension aimed at resource developers, regulatory officials, resource management agencies, and the public to provide objective, science-based information on Best Management Practices for restoring damaged ecosystems in marine, estuarine, and coastal watersheds.
- Revitalize marine debris cleanup projects by K–12 schools and other service groups.
- Conduct research and outreach that will reduce improper disposal of domestic and industrial solid wastes in marine, estuarine, and riverine systems.
- Institute the Clean Marina Program in selected harbors.
- Conduct extension and education programs to alert people to the existence and potential negative effects of invasive species, and how to identify and report sightings of invasive species.
- Conduct periodic surveys to detect the presence/absence of invasive species.
- Collaborate with Sea Grant programs and others on large-ship ballast water treatment studies and mitigation experiments.
- Contribute science-based information to the development of marine policy through involvement in regional, national, and international advisory panels.

Outcomes/Impacts

- The level of knowledge of Alaskans and decision-makers about the role and function of habitat in ecosystems is increased.
- The level of knowledge of Alaskans about invasive species is increased.
- Concerns of coastal Alaskans are incorporated into resource agency and policy discussions.
- Alaskans and decision-makers are knowledgeable about restoring damaged ecosystems in marine, estuarine, and coastal watershed environments.

Indicators

 Evidence of increase in the use of Alaska Sea Grant information by public policysetting and regulatory bodies. "Research needs to support improved management and improved trust in science-based management decisions, such as habitat mapping, food web dynamics, and fishing gear impacts."

Survey respondent

- Number of research studies on habitat as a function of the larger ecosystem, and the critical relationship between life history stages and ecosystem health.
- Number of extension education projects on the importance of healthy ecosystems.
- Number of people who attend extension programs and workshops on healthy ecosystems and the role of habitat in ecosystems.
- Development of Best Management Practices for restoring damaged habitats in marine, estuarine, and coastal watershed ecosystems.
- Number of people who know how to identify and report invasive species.
- · Number of incidents of invasive species.

OBJECTIVE 2

Conduct outreach activities with coastal community members, tourists, recreational users, industry, and others to enhance the understanding of the value of healthy ecosystem function, negative human impacts on ecosystem function, and environmental emergencies.

Strategies

- Involve the public in monitoring the marine environment and resources as a way to increase knowledge and understanding of coastal ecosystem function.
- Encourage prevention of and response to marine mammal or seabird interactions with humans such as bycatch, entanglements, strandings, military (sonar), rocket launches, shellfish farming, fisheries, shipping noise, and ports and harbors.
- Conduct education and extension that conveys Best Management Practices for marine wildlife viewing.
- Promote involvement of coastal residents in understanding, prevention, and response to environmental emergencies such as oil spills, animal die-offs, coastal storms, tsunamis, and pathogen outbreaks.
- Inventory/survey the status of marine debris receptacle stations and debrishandling procedures in coastal towns.

Outcomes/Impacts

- Less harassment of marine wildlife occurs by visitors, charter boat operators, or tour companies, due to their use of responsible viewing guidelines.
- Deleterious human interactions with marine wildlife, such as shipping noise, entanglements, strandings, bycatch, oil spills, and other potential hazards, are reduced or mitigated.
- University resources and expertise are readily available and useful to coastal residents and others responding to environmental crises.

• Informed coastal residents develop and implement protocols to detect environmental anomalies and monitor or initiate responses.

Indicators

- · Development of Best Management Practices for wildlife viewing.
- Number of people who attend workshops and number of publications distributed that educate people to avoid adverse impacts on wildlife and ecosystems.
- Number of charter boat operators or other tourism operations that use Best Management Practices around marine wildlife.
- Number of incidents reported and citations issued for wildlife harassment violations.
- Number of people who attend workshops and participate in other educational efforts directed to prevention and education about adverse human impacts on ecosystems.
- Publication of a directory of university resources and expertise available in environmental emergencies, and number distributed to coastal communities.
- Number of entanglements, strandings, oil spills, and other potential hazards.
- Rate of bird bycatch in the small-boat longline fishery.

"A pressing issue is degradation of habitat through increasing human uses for waste disposal, recreation, extractive commercial operations, home building, and other human infrastructure development."

Survey respondent



Unalaska Marine Advisory agent Reid Brewer, former Alaska Sea Grant associate director Susan Sugai, and Marine Advisory Program instructional media specialist Deborah Mercy provided onsite help during the December 2004 foundering of the Malaysian freighter Selendang Ayu, near Dutch Harbor. Soon after, marine conservation specialist Rick Steiner convened a workshop to explore what might be done to improve transport safety in the region.

Healthy Marine Ecosystems

A healthy marine ecosystem has intrinsic ecological and aesthetic value and is essential for sustaining the diverse marine life and natural features that draw people to California's coast.



A healthy marine ecosystem is the essence—and end result of—successful marine steward-ship. It is also the core of the California Sea Grant program. Three main forces drive our efforts to improve and maintain marine health: the desire to understand marine species and their environment, the need to identify the consequences of human activities for these species and environments, and the possibility for alleviating these impacts. California Sea Grant strongly encourages collaborative research through partnerships with fishers, resource agencies and nongovernmental organizations to find effective solutions to problems related to marine ecosystem health.

Goal HME 1

Provide information to conserve, restore and manage coastal and marine ecosystems to ensure their long-term health and productivity

Objective

Study interactions between marine living resources and their environment

Objective

Identify habitats that support areas of high biodiversity and develop tools and techniques to protect and restore these areas and associated species

Objective

Examine impacts of human activity on ecosystems and seek scientifically sound, socially responsible options to reduce or eliminate these impacts

Objective

Study watershed processes as they impact marine ecosystems and contribute to ecosystem-based management

-Goal HME 2

Assist in preventing introductions of non-native plants and animals and manage (and if possible eradicate) already established populations

Objective

Improve the basic biological understanding of non-native species and their dispersal

Objective

Evaluate relative social, economic and ecological consequences of non-native species to better prioritize and coordinate management strategies

Objective

Study effectiveness of invasive species control technologies and management practices, including ecosystem recovery and vulnerability to re-infestation

Objective

Develop methods and educate audiences about ways to minimize the spread of invasive species and why this is important



Goal HME 3

Assist in reducing coastal water and sediment contamination in the marine environment to protect ecosystem and human health



Objective

Understand sources of contamination, their transport, fate and implications for marine life and public health

Objective

Develop tools for detecting contamination to address emerging concerns, including the increased occurrence of harmful algal blooms, beach closures and toxin bioaccumulation in the marine food web

Objective

Facilitate multi-agency partnerships, research collaborations and grass-roots efforts to minimize the impacts of biological and chemical contamination

- Increased understanding of the impacts of shellfish aquaculture on the marine environment.
- Regulatory agency staff more knowledgeable about the aquaculture industry.
- Increased awareness among growers (aquaculture producers) of their environmental impacts on the environment.
- Increased understanding by the public, government, managers and industry on the costs and benefits of aquaculture biotechnology.
- Acquisition of new skills and information by growers that will enhance production and/or marketing.
- Acquisition by students of new knowledge and skills that will prepare them for a career in the field of aquaculture.
- Provision of guidance in the application of marine biotechnology to industrial and aquaculture uses.
- Improved understanding of the marine biotechnology by policy makers, regulators, industry and the public.

Theme Two: Use and Conservation of Marine Resources, Ecosystems and Habitats

Theme Two Goal

To support management efforts to conserve and protect ecosystems, habitats and living resources in Long Island Sound's watershed, Connecticut and the Northeast United States.

Theme Two Objectives

- Conduct research, education and outreach to provide greater understanding among Connecticut and Long Island Sound residents and those making policy decisions regarding the role and function of habitat in the marine and coastal ecosystems.
- Develop collaborative partnerships with national, regional and state management agencies; non-governmental organizations; industry; and citizen organizations to improve living resource and habitat management efforts, including fisheries and ecosystem-based management.

The strategy for this theme contains four sub-themes: (1) coastal land use and community planning; (2) habitat restoration and enhancement, (3) aquatic invasive species; and (4) use and conservation of marine resources.

Sub-theme 2A: Coastal Land Use and Community Planning

Land use is at the heart of many conservation issues. The land use/water quality connection, in particular, has been touted in recent high-profile federal reports, including the U.S. Commission on Ocean Policy. Land use is determined at the most local level of government, yet it is the victim of a federal and state "mission gap" that precludes the considerable expertise, effort and funding that are necessary for a coordinated strategy to address the many land use issues we face as a nation.

When addressing the challenges of coastal land use and community planning the experience of

the NEMO program has found that education – not regulation – is the most effective, and most cost-effective, means of influencing land use decision. The educational goal is to demystify land use planning and provide technical tools and support, to enable town officials to be more proactive in protecting the character and natural resources of their community. Communities can, and do, accomplish many great things, given a little catalytic education and assistance.

Sub-Theme (2A) Problems and Challenges

- Lack of understanding among State and regional residents regarding the role and function of habitat in marine and coastal ecosystems
- Loss and degradation of critical marine and coastal habitats
- Lack of appropriate plans and partnerships to preserve marine and coastal ecosystems and prevent further loss and degradation
- Increasing development in the Connecticut coastal zone
- Point and non-point source pollution of Long Island Sound
- Lack of public understanding of water quality issues and sources of pollution in Long Island Sound
- Federal and state "mission gap" that precludes the considerable expertise, effort and funding that are necessary for a coordinated strategy to address the land use issues
- Dated community land use plans unable to account for contemporary patterns of land use and development
- Need for land use and other information at the community level to facilitate appropriate decision making and planning.

Sub-Theme (2A) Expected Outcomes

Coastal communities, decision makers and development professionals will gain a greater understanding of the type, location and threats to their coastal resources; initiate planning efforts to implement policy changes; inform their decisions with geospatial information; adopt and implement more effective and environmentally-friendly stormwater management practices; and gain increased awareness of the importance of, and techniques to protect, vegetated riparian buffers.

Sub-Theme (2A) Strategies

- Conduct research, outreach and education:
 - to characterize land cover and land cover change for all coastal riparian corridors and to assist Long Island Sound Study managers in prioritizing coastal riparian corridors for both restoration and preservation initiatives.
 - o to provide science-based information about land use impacts on water quality and coastal resources for coastal communities land use decision makers.
 - o on geospatial and resource information to coastal resource managers, decision makers, and communities.
 - o to prioritize coastal properties for public access and open space preservation.
- Conduct research to locate and track the success of development using low impact development (LID) techniques and provide this information through an on-line database for development professionals and local land use decision makers.
- Conduct outreach:
 - o on the Connecticut Stormwater Quality Manual for coastal communities and

- professional organizations representing the development and conservation communities.
- o to assist selected coastal communities in their efforts to incorporate planning and policy tools into their regulations for coastal resource protection.

<u>Sub-Theme (2A) Benchmarks (Short and Long-Term):</u>

- At least six coastal communities will develop coastal resource inventories and incorporate them into community master plans
- A new web-based resource for coastal communities will be developed, enabling citizen planners, commissioners and other stakeholders to produce and assemble town and watershed-level maps of their natural resources and other key data layers.
- A new web-based resource for coastal communities will be developed, enabling them to
 obtain information, photos, and local contacts on Low Impact Development practices,
 resulting in higher adoption rate of Low Impact Development practices in coastal
 municipalities.
- A new web site disseminating new research information on coastal riparian area land cover and land cover change will be created for natural resource managers and for coastal land use decision makers; at least 10 coastal communities will be exposed to the information through SGE workshops.
- At least five coastal communities will make changes in local land use regulations to reference the new state Stormwater Quality Manual.
- Two coastal communities will develop improved land use plans and regulations resulting in better riparian buffer restoration/protection.
- State Coastal Zone Management plans and grant proposals for preserving coastal open space will be improved with research information created by the SGE, in collaboration with the Center for Land Use Education and Research.

Sub-theme 2B: Habitat Restoration and Enhancement

Long Island Sound is a nationally significant estuary located in the densely populated metropolitan New York City region. The Long Island Sound estuary provides both economic and ecological benefits. Pressures from the region's large population have resulted in estuarine habitat loss and degradation. In the past century, more than one-third of the Sound's tidal wetlands have been lost. Eelgrass beds that once grew throughout the Sound are in a state of decline. Today's coastal forests and coastal grasslands comprise only a fraction of their original acreage around the Sound. The rapid loss of wetlands and other important habitats has slowed due to state and federal wetland protection legislation and coastal management plans, but pollution and invasion of non-native species continues to degrade Long Island Sound habitats. Unless this trend is altered by the preservation of significant habitats and restoration and enhancement of degraded habitats, the Long Island Sound ecosystem, even as it currently exists, will not be sustained for the future.

Restoration and enhancement should strive to restore a diversity of plant and animal species. Habitats in Long Island Sound in need of restoration and enhancement include tidal wetlands; riverine migratory or riparian corridors; beaches, dunes, cliffs and bluffs; estuarine embayments; submerged aquatic vegetation; coastal, island or maritime forests; shellfish reefs; coastal and

maritime grasslands; rocky intertidal zones; and intertidal flats. Restoration and enhancement projects should be community-based and should take into account the watershed as a whole.

Sub-Theme (2B) Problems and Challenges

- Lack of understanding among State and regional residents regarding the role and function of habitat in marine and coastal ecosystems
- Loss and degradation of critical marine and coastal habitats
- Lack of appropriate plans and partnerships to preserve marine and coastal ecosystems and prevent further loss and degradation
- Increasing development in the Connecticut coastal zone
- Pollution and invasion of non-native species in Long Island Sound
- Need for partnerships to facilitate community-based restoration efforts
- Need for additional information regarding vulnerable coastal ecosystems in need of protection or restoration.

Sub-Theme (2B) Expected Outcomes

Progress towards the restoration and enhancement of habitats in Long Island Sound to a healthy, functioning system.

Sub-Theme (2B) Strategies

- Conduct research and outreach:
 - to facilitate long-term interactions between researchers, state regulatory agencies, local organizations, industries, and coastal property owners in Long Island Sound in planning, financing and completing habitat restoration and enhancement efforts.
 - o on specific techniques for the restoration and enhancement of all types of habitats.
- Conduct outreach and education:
 - o to prevent habitat alteration and destruction.
 - o for community-based restoration and enhancement projects to promote local stewardship.

Sub-Theme (2B) Benchmarks

- Restored and enhanced coastal habitats for ecosystem benefit.
- Enhanced shellfish beds for commercial activity.
- Improved methods for the economic valuation of aquatic habitat restoration and enhancement
- More knowledgeable citizens on the factors leading to habitat alteration and destruction and on means to prevent habitat alteration and destruction.
- More knowledgeable students on the factors leading to habitat alteration and destruction and on means to prevent habitat alteration and destruction.
- Enhanced partnerships among stakeholders (land owners, government, public) to engage in community-based restoration and enhancement projects.

Sub-theme 2C: Aquatic Invasive Species

The introduction and spread of aquatic nuisance species (ANS) in marine and freshwater environments pose a serious threat to the ecology and biodiversity of native ecosystems and to

the health and economic interests of the people of the State of Connecticut. Aquatic invasions pose difficult challenges to natural resource managers. Once established, populations of ANS are often self-sustaining. Effective ANS management requires ongoing efforts devoted to the prevention of new introductions and to the eradication and/or control of existing populations. Non-indigenous species have the potential to establish and spread rapidly due to a lack of physical or biological constraints. The range of ANS impacts is extensive and includes degradation of habitat or ecosystem structure, localized extinction of rare species, spread of pathogens, choking of waterways, clogging of industrial water intakes and wetland systems, fouling of water supplies, and interference with recreational activities such as fishing, boating and swimming.

Sub-Theme (2C) Problems and Challenges

- Introduction and spread of aquatic nuisance species (ANS) in the marine and freshwater environments
- Need for effective ANS management plans and efforts
- Loss and degradation of critical marine and coastal habitats and human uses of ecosystems
- Lack of appropriate plans and partnerships to preserve marine and coastal ecosystems and prevent further loss and degradation
- Need for partnerships to facilitate ANS management efforts
- Need for additional information regarding vulnerable coastal ecosystems in need of protection or restoration.

Sub-Theme (2C) Expected Outcomes

Progress towards greater awareness of aquatic nuisance species issues and implementation of policy and strategies to minimize new introductions and mitigate the effects of established invaders.

Sub-Theme (2C) Strategies

- Seek funding and conduct outreach to implement a coordinated approach to minimizing the ecological, socioeconomic and public health impacts of aquatic invasive species in the State of Connecticut; and to facilitate the development of a Connecticut-New York framework to jointly address the protection of Long Island Sound's biodiversity, key commercial species, and marine and coastal habitats from the impacts of introduced aquatic species.
- Conduct education and outreach:
 - o concerning significant vector communities that may introduce marine organisms to and from the Northeast region (Maine to New York), to appropriate users to raise awareness and modify behaviors that will prevent, reduce, or minimize the spread of non-native marine species region-wide.
 - o on aquatic invasive species (AIS) by providing science-based information to students and teachers.
- Conduct research and outreach to quantify the threat of invasive species to commerciallyimportant shellfish and other species, test methods that can be used to eliminate or control these invaders, and assess the economic implications of fouling and alternative control measures to interested and appropriate stakeholders.

• Conduct outreach to maintain public awareness of the issue of aquatic nuisance species.

Sub-Theme (2C) Benchmarks (Short and Long Term)

- Adoption and implementation of a Connecticut aquatic nuisance species management plan.
- Development and adoption of a bi-state Long Island Sound aquatic nuisance species management plan.
- Research undertaken to identify and address local/regional problems on the spread of invasive species.
- Educational programs targeted at a range of audiences to raise awareness of the issue.
- More efficient use of available resources to address the priority ANS problems in Connecticut.
- Continued partnerships with EPA-Long Island Sound program, Connecticut Department of Environmental Protection, CLEAR to increase overall awareness and understanding of the problems caused by ANS.
- Greater awareness among recreational boaters of the risk of marine aquatic introductions from fouled hulls and of hull maintenance options.
- Commercial shellfish operations benefit economically from reduced workloads and product losses through the reduction and control of fouling by aquatic nuisance species.

Sub-theme 2D: Use and Conservation of Marine Resources

The Long Island Sound watershed is home to more than 8 million people, with millions more flocking yearly to its shores for recreation. Over 20 million people live within 50 miles of the Sound. The Sound is characterized by multiple uses by multiple user groups. Ferries, ships and barges transport people and goods into deep water harbors. Commercial fishing and shell fishing provide income and employment. Recreational fishermen target a range of species. Boaters, beach swimmers and sunbathers by the thousands enjoy the Sound's beaches, waters and marinas. Birdwatchers can delight in a variety of shore birds, song birds, and birds of prey, among other avian species.

The ability of the Sound to support these diverse uses is dependent on the quality of its waters, living resources, and habitats. These activities in the Sound generate more than \$5 billion annually in the regional economy. With the uses it serves and the recreational opportunities it provides, Long Island Sound is among the most important and valuable estuaries in the nation.

While commercial fishing remains an important Connecticut maritime industry, collective exvessel landings valued at \$49 million in 1993 declined to about \$30 million in 2003. This decline is in part a result of state and regional fisheries management actions which have limited access and imposed quotas for various species in an effort to re-build sustainable stocks. It is also the result of a major blow when the bi-state fishery for American lobsters, worth \$40 million in the mid-1990s, was devastated by a mortality event in late 1999. Annual landings by Connecticut lobstermen alone declined from 3.7 million pounds in 1998 to 670,000 pounds in 2003, and recovery of the lobster population remains slow. Unfortunately, the southern New England lobster population also suffers from epizootic shell disease, causing extensive pitting and lesions of the lobster's carapace, further exacerbating the decline of the fishery.

On the positive side, one sector of the main offshore port located in the southeastern Connecticut town of Stonington is experiencing some growth. Reaping the benefits of sea scallop management actions and buoyed by 2003 landings worth \$8 million, several fishing families have purchased additional scallop boats. This, in turn, prompted the local commercial fishing association to apply for state and federal permits and grants to extend the dockage available to accommodate the increase in fleet size.

Considering recent changes and pressures, there is concern that current approaches to fisheries management do not adequately respond to the problems of the New England commercial fisheries. A number of possible alternative fisheries management measures are available, including collaborative management, harvest cooperatives, marine protected areas, ecosystem-based management, and rights-based fisheries management. CTSG will work in the region to improve understanding of these measures. Saltwater recreational fishing is also a major economic activity in Long Island Sound. CTSG will work to promote sustainable fishing opportunities, heighten awareness of marine recreational fishing issues, and advance marine conservation principles.

Sub-Theme (2D) Problems and Challenges

- Decline of commercial fishing in Connecticut and regionally
- Collapse of bi-state (CT and NY) lobster fishery
- Shell disease in Long Island Sound lobster populations
- Need for improved fisheries management in New England
- Need for improved implementation of ecosystem-based fisheries management
- Lack of appropriate plans and partnerships to preserve coastal and marine resources
- Need for science-based information to support resource and fishery management efforts
- Need among fishers for information on livelihood diversification strategies
- Lack of information among local residents regarding resource stewardship
- Need for HACCP training among seafood processors
- Need for improved communications between resource users and regulators.

Sub-Theme (2D) Expected Outcomes

Improved water quality and conservation and protection of habitats and living resources in Connecticut and the Northeast United States.

Sub-Theme (2D) Strategies

- Conduct research:
 - o to improve scientific understanding of acute and cumulative effects of physical, chemical, and biological contaminants on marine and coastal ecosystems.
 - o to identify methods to minimize negative effects of human-caused impacts on marine and coastal ecosystems.
 - o on the impacts of water quality problems (hypoxia, toxic contamination, pathogen contamination, debris) on the health of marine and coastal ecosystems.
- Conduct outreach and education:

- o aimed at resource developers, regulatory officials, resource management agencies, and the public to provide objective, science-based information on best management practices for use and conservation of marine and coastal resources.
- o to encourage direct communication between fisheries management personnel and fishing constituents and partnerships for collaborative research and management.
- o to increase environmental stewardship practices and informing marine recreational anglers of management and policy issues.
- o on safe and healthy seafood consumption and provide current, science-based information on seafood-related "hot" issues
- o for Connecticut harvesters, processors and importers who must comply with the 1997 FDA safe seafood processing regulation so that they can develop and maintain appropriate and adequate HACCP and sanitation control plans, and understand how to implement and follow them successfully.

• Conduct research and outreach:

- o on critical issues relevant to Connecticut's three major commercial fishing sectors: shellfish, lobster and finfish.
- on experiences with alternative fisheries management strategies in New England and the United States; reviewing the Connecticut fisheries management experience and performance; assessing problems and opportunities in Connecticut fisheries and management; and recommending alternative management strategies.
- o on livelihood diversification for commercial fishermen as a result of changes occurring in the fisheries.
- o on the status and value of recreational fishing in Connecticut.

• Conduct outreach:

- with industry, user groups, and government on fisheries management, including collaborative management, harvest cooperatives, marine protected areas, ecosystem based management, adaptive management and rights-based fisheries management.
- o to provide scientists and agency staff an annual opportunity for classroom and hands-on training in safety procedures and gear operation.

Sub-Theme (2D) Benchmarks (Short and Long-Term)

- Improved understanding of fisheries management alternatives for commercial and recreational fishermen in Connecticut and New England.
- More informed and active fishery sector stakeholders on fishery management.
- Improved information on livelihood diversification strategies for commercial fishermen.
- Increased number and percent of individuals in the Southern New England seafood industry trained in HACCP principles.
- Seafood processors, harvesters, importers, and dealers will be able to remain in business by having continued regular and local access to HACCP and sanitation control training and updates, enabling them to expand the number of trained employees they have and/or address HACCP-trained employee turnover.
- Increased student access to training in HAACP principles.
- Consumers will have increased awareness and be able to make more informed choices concerning seafood consumption.

• Accountability — Performance-based evaluations from both internal and external perspectives are used to measure achievements. These include tracking of scholarly publication output and graduation of sponsored students, documenting the contribution to society of scientific discovery, measuring behavioral change of the public upon receipt of educational programs, and determining the economic impact resulting from research and technology transfer.

DELAWARE SEA GRANT'S PRIORITIES

The Delaware Sea Grant College Program has established the following five priority areas for research, education, and outreach: Ecosystems; Environmental Technologies and Engineering; Biotechnology; Marine Commerce and Transportation; and Marine Education, Literacy, and Outreach.

1. ECOSYSTEMS

Expand the scientific and policy basis critical to sound ecosystem-based management in the wise use, protection, and restoration of coastal waters, estuaries, and watersheds and their living marine resources.

Background

It is often cited that 50% of the world's population lives within 100 km of a coast. In Delaware all three of the counties are considered coastal and are experiencing substantial population growth. The greatest growth is occurring in Delaware's southernmost county, which is bordered by both a bay and the ocean. At the same time, evidence has mounted that there are limits to the stress the coastal ocean and watersheds can withstand and still remain viable. Recent symptoms include hypoxia, fish kills, and toxic algal blooms.

In recent years, the concept of environmental sustainability has been embraced, and even legislated, as a goal for natural resource management agencies. In practice, however, management agencies have found implementation of this mandate difficult. Several obstacles stand in the way of ecosystem-based management, including (1) inadequate information on the biodiversity of the environments; (2) lack of understanding of the function and dynamics of ecosystems; (3) the openness and interconnectedness of ecosystems on scales that

transcend management boundaries; and (4) the belief by some that immediate societal need and economic value of supposedly renewable resources outweighs the risk of future ecosystem damage.

Before ecosystem-based management can be implemented, there must be a clear understanding of the ecological interactions and processes necessary to sustain ecosystem composition, structure, and function. Since the early 1980s, Delaware Sea Grant researchers have carried out studies to determine how major estuarine systems work. A bi-state study (Delaware and New Jersey Sea Grant) of the Delaware Estuary was initiated in 1983 with substantial support coming from the Delaware River and Bay Authority. While this infusion of matching financial resources lasted only two years, Delaware Sea Grant researchers have continued to study the complex biogeochemical interactions of the Delaware Estuary. In parallel, similar studies were initiated in Delaware's Inland Bays.

While Delaware Sea Grant has contributed to a better understanding of the dynamics of these estuarine ecosystems, ecosystems vary spatially and change with time. No ecosystem is closed with respect to exchanges of organisms, matter, and energy. Ecosystem function includes inputs, outputs, cycling of materials and energy, and the interactions of organisms. Biological diversity is both a critical and dynamic property of ecosystems; it must be recognized that the complexity and function of any particular location is influenced heavily by the surrounding system. Ecosystems also are changing constantly; over time scales of decades or centuries, many areas are altered by natural disturbances that lead to the creation of thriving "patches." Such patch dynamics are critical to ecosystem structure and function. While change in ecosystems is normal, what is not normal is the rate of change that is occurring today. The rapidity of change and the impact of many humans present special challenges in fully understanding ecosystem dynamics.

Expected Outcomes

Ecosystem-based management is as much about managing human behaviors as it is managing natural resources. The mismatch between the scales at which humans must make resource management decisions and at which ecosystems operate presents a significant challenge for ecosystem-based management. Ecosystem-based management requires application of ecological science to natural resource actions. Moving from concept to practice is a daunting challenge and will require ongoing interactions among scientists, resource managers, and the public.

Thus, the primary intent of this priority area is to assist in the development of science-based ecosystem management practices and informed decision making.

Objectives

- Understand the interrelationships of coastal ecosystem processes including hydrologic flux and storage, biological productivity, biogeochemical cycling and storage, decomposition, and maintenance of biological diversity.
- Understand the contribution and impact of materials from various external sources (groundwater, runoff, atmospheric deposition, dredge spoil, point sources) introduced into coastal ecosystems.
- Understand the relationship between external nutrient supply and algal blooms.
- Determine relationships between nutrient over-enrichment and habitat loss.
- Develop indicators of water quality and habitat health that will document change/progress toward ecosystem health.
- Determine methods to economically quantify impacts of contamination in watersheds.
- Assess economic feasibility and impact of various coastal ecosystemmanagement, restoration, and rehabilitation strategies to effect desired change.
- Develop risk assessment models to predict cumulative effects of ecosystemmanagement strategies.
- Educate citizens and government officials regarding the specifics, complexities, and challenges of ecosystem-based management.
- Provide opportunities to citizens to become involved in activities in support of the management of coastal ecosystems.

Performance Benchmarks

- Increase the number of connections/partnerships between ecosystem research projects and resource managers to facilitate management-based research and ecosystem-based management.
- Increase the number of projects that foster a multidisciplinary approach to ecosystem research.
- Increase the veracity of ecosystem models to predict the outcomes of various natural and human-induced changes on the coastal ecosystem.
- Enhance public understanding of the relationship between human impact and factors such as water quality and habitat health.

2. Environmental Technologies and Engineering

Develop interactive observatories, sensors, autonomous samplers, and models for real-time, continuous, cost-effective monitoring, forecasting, and assessment.

Background

America's coastal waters are of vital national importance. There is a need to improve observations and modeling of critical phenomena that impact operations, activities, and human health and safety in coastal environments. Since the early 1970s, Delaware Sea Grant has supported coastal engineering research. This research has been directed largely at understanding wave dynamics and coastal processes with the goal of predicting and mitigating coastal erosion.

Presently, technologies have progressed to allow researchers to think beyond the nearshore for real-time dynamic sampling. Two fundamental capabilities are required to make rational, scientifically sound decisions about a host of activities that impact the coastal ocean, bays, estuaries, watersheds, and coastal shorelines:

Coastal Stewardship and Public Safety

Florida estuaries, where freshwater from the land meets saltwater from the sea, are characterized by enormous ecological, social and economic diversity. Most of the species that support Florida's multibillion dollar fisheries depend on estuaries to complete their life cycle. Meanwhile, most of Florida's urbanization is taking place alongside estuaries and placing stress on the quality and quantity of these valuable habitats. The Florida shore and its coastal inhabitants are at risk from a variety of natural hazards, most notably the winds, waves and floods generated by hurricanes. Risks to life and property from these recurring hazards can only increase, given the anticipated growth of coastal populations over the next several decades. There needs to be a dedicated effort to reduce the economic, social and personal losses due to natural hazards. All stakeholders share an interest in pursuing loss (or cost) control which is a proven risk management technique.

Goal 6. Ecosystem Health

Protect, Restore and Enhance Coastal Ecosystems

Description

Coastal waters around the world represent less than 10 percent of the ocean's surface, yet they account for 50 percent of its biological productivity. People make extensive use of coastal areas and their productivity. For example, a wide variety of commercially and recreationally valued species find shelter and food in healthy coastal habitats. Unfortunately, people's activities can lower coastal productivity by degrading water quality and habitats. Altered inputs of freshwater and nutrients can degrade water quality leading to loss of habitats. Habitats can also be lost to direct destruction, whether it is accidental or for coastal development or other purposes.

In Florida, coastal waters are critical to the state's beaches, estuaries and bays. Florida's coastal habitats include beaches, salt marshes, mud flats, mangroves, sea grasses, open sand, bivalve and tubeworm reefs, hard bottom and coral reefs. The productivity and beauty of these coastal ecosystems create significant benefits for the state. Coastal waters and habitats provide support during a part of the life cycle for up to 90 percent of the fish and shellfish species that comprise commercial and recreational harvests. High-quality coastal waters and habitats represent a key reason that millions of boaters, divers and tourists visit the state each year. Coastal ecosystems attract people. They also help shield the state's coastaline from storm damage, so all Floridians have a stake in the quality of coastal waters and the health of coastal habitats. Since all of Florida sits within the coastal zone, activities anywhere in the state have the potential to affect coastal ecosystems.

Forces of Change

In terms of water quality, Florida has reduced the amount of pollution coming from non-point sources and pollutants, but diffuse sources associated with storm water or atmospheric deposition remain prime concerns. For example, landscaping, agriculture, home maintenance and use of internal combustion engines affect coastal water quality by adding nutrients and pollutants to Florida's watersheds and air sheds. In general, diffuse sources of pollution increase along with the annual increase in Florida's population. In response to the cumulative stress generated by these diffuse sources, management of coastal water quality has shifted from a focus on permits for point sources to a focus on ambient conditions and total maximum daily loads. Management focused on ambient conditions and loads will benefit from stronger scientific analysis of Florida's watersheds and "airsheds" and their responses to our actions.

Florida's coastal habitats are also subject to a variety of stresses, including accidental destruction, loss due to development, pollution of coastal waters, reduced freshwater flow and introduction of non-native species. Habitat destruction and loss produce relatively obvious effects and management of these pressures is improving. Attention has turned to management of the more subtle effects of poor water

quality, reduced freshwater flow and non-native species, which are more significantly influenced by natural, spatiotemporal variation. For example, minimum flows and levels are being set to maintain appropriate freshwater flow to coastal areas and early detection and rapid response plans are being developed to deal with invasions by non-native species.

Measurable Goal

Protecting, restoring and enhancing the quality of Florida's coastal ecosystems remains a key goal for the Florida Sea Grant College Program. Important, long-term performance measures include reduced pollution loads; decreased degradation of water quality; less loss of habitat; successful restoration, mitigation, or enhancement of ecosystems; increased use of best practices; and increased citizen involvement in management.

Past efforts by Florida Sea Grant focused on two separate goals targeting water quality and habitat. Recent work addressing water quality primarily comprises outreach and education projects targeting watersheds, the Comprehensive Everglades Restoration Plan, the urban-wild land interface, volunteer water quality monitoring, monofilament recycling and coastal clean-ups. Research and outreach projects dealing with Florida's habitats focused on plankton as invasive species in the Indian River Lagoon; general education on invasive species; assistance for 32 county artificial reef programs around the state; and assistance with efforts to restore dunes, beaches, mangroves and oyster reefs. The two goals have been combined in keeping with their interrelatedness and the shift to ecosystem management.

Audience

Due to the ubiquitous importance of coastal ecosystems, Florida Sea Grant targets many audiences. In particular, the program works with researchers, state and local management and regulatory agencies, coastal residents, extension faculty and formal and non-formal educators. The program delivers value by supporting the production of articles in scientific journals, more publicly accessible publications, a web site, training workshops and organizational meetings. Researchers, extension faculty and the communications staff generate these products and activities. Researchers receive direct funding supported from Florida Sea Grant and support during national competitions. Florida Sea Grant's statewide specialists and county faculty provide support to education and outreach efforts.

Performance Indicators

Successful efforts produce short-term to medium-term outcomes and long-term impacts. Key performance measures for outcomes include proof of concept for management practices and increased awareness and knowledge among managers, regulators and citizens. Long-term impacts stem from uptake and application of best practices by managers, regulators and citizens.

Objectives

A. Improve tools and techniques to measure non-point source pollution

- 1. Improve tools and techniques to identify sources and measure loads to coastal waters from non-point sources, with recognition of natural, spatiotemporal variation in loadings.
- 2. Improve tools and techniques to reduce non-point source pollution, including proof of concept for best practices to be implemented by citizens, businesses and agencies.

B. Increase the knowledge base that causes the protection, restoration and enhancement of coastal systems

- 1. Increase knowledge and predict changes in coastal habitats arising from changes in freshwater flow to the coast, especially by elucidating cause and effect linkages.
- 2. Increase knowledge and predict changes arising from restoration, mitigation, or enhancement of coastal habitats, especially changes related to the deployment of artificial reefs.

- 3. Raise awareness and knowledge of key issues related to coastal ecosystems, including non-point source pollution, watersheds, invasive species, restoration and ecosystem function.
- 4. Promote citizen and affected business involvement in the protection, restoration and enhancement of coastal ecosystems, including volunteer monitoring, clean-ups and use of best practices.

Florida Sea Grant will continue to pursue this goal until management of coastal ecosystems is effective. Effective management will be adaptive, with a strong base in scientific understanding, rigorous monitoring and in-depth reporting to all concerned parties. In addition, effective management will involve citizens as active participants. The program will help state and local managers and regulators, as well as citizens and businesses. Florida Sea Grant's focus on basic research linked strongly to management and public education distinguishes it from other organizations pursuing a similar goal. In an effort to promote differentiation in research funding, the program will not fund studies that focus on identifying new influences on water quality or new indicators of ambient water quality without evaluating them in relation to existing influences and measures. Such studies provide little help to stakeholders who must prioritize influences and indicators in order to deliver effective and efficient management. In addition, Florida Sea Grant will not fund baseline sampling to establish loads or long-term monitoring of water quality because such efforts fall in the purview of agencies. Research on water quality will not be funded unless it takes place at sites with existing management in order to leverage resources more fully. Florida Sea Grant also will not fund studies examining the effects of direct habitat loss or how habitats support fisheries because such studies fall in the purview of agencies. The program also will not fund studies that focus on invasive species because support is available through national competitions for aquatic nuisance species from the National Sea Grant College Program.

Florida Sea Grant has the potential to be in the top 5 percent of all Sea Grant programs addressing coastal ecosystems. It has access to many qualified scientists and outreach personnel. In addition, Florida is moving to address non-point source pollution through Phase II of the National Pollution Discharge Elimination Scheme and use of total maximum daily loads. In the near future, minimum flows and levels will be set for many of the state's waters. Florida Sea Grant can contribute by funding rigorous small-scale and short-term studies that provide managers, regulators, businesses and citizens with improved understanding of causal links driving changes in coastal ecosystems and science-based tools and techniques that have been proven in concept.

Most of the priorities associated with this goal carry moderate to high risks. Non-point sources of pollution are awkward to identify and manage. These risks should be faced because non-point source pollution represents the major reason that over 40 percent of the rivers, lakes and estuaries in the United States do not support swimming, fishing and other basic uses. Efforts to understand changes in coastal habitats must address the uncertainties introduced by natural, spatiotemporal variation. These risks should be faced because coastal habitats play such critical roles in the economy and environment of Florida. Risks become smaller if projects have strong and viable links to existing management of coastal ecosystems and outreach efforts that form part of coherent, long-term programs building from basic, generic concepts to specifics tailored to the state's coastal counties.

Additional Resources Needed

Florida Sea Grant has a statewide specialist that works in the area of coastal ecosystems education. Thus, adding resources to this goal area is not the highest need at this time. State and federal agencies also are investing millions of dollars annually to support research in this area, thus Sea Grant can complement this activity through extension-based public education.



CHARTING OUR COURSE

STRATEGIC PLAN

Taking into consideration the priorities of our advisory board of constituents and stakeholders and the strategic plans of National Sea Grant and NOAA, Georgia Sea Grant has identified the four following areas on which to focus its effort.

1. COASTAL COMMUNITIES AND ECONOMIES

Georgia's coastal population is growing rapidly. Along with this growth comes economic change. If coastal communities are to thrive and prosper, they must shape this growth and direct these changes. Georgia Sea Grant hopes to develop science and deliver information that will help create a sustainable vision for the future of our coast.



GOALS:

- 1. Evaluate and foster sustainable economic development alternatives in the coastal region.
- 2. Develop long-range planning tools and management practices for coastal development.
- Describe the link between population growth and the status of coastal resources.

2. ECOSYSTEMS AND HABITATS

Most of the rivers that drain the state flow to the Georgia coast. On the coast, water from the interior mixes with seawater to form one of the most prductive environments on earth: the Georgia salt marsh. It is critical that we develop a deep understanding of this ecosystem - one that can be used to protect the marsh and estuary system that nourishes our fisheries and attracts tourists and new residents.



GOALS:

- 1. Characterize the freshwater inflow requirements of a healthy estuarine system.
- 2. Determine baseline sea level for selected marshes in order to track and study effects of sea-level rise.
- Describe how land-based activities affect the health and productivity of estuaries.



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G. Nearshore Resources

With increasing population and urbanization, coastal and nearshore resources have experienced significant deterioration in Hawai'i. Over-fishing, non-point source pollution, introduction of alien species, habitat destruction and changes due to natural fluctuations have all contributed to the problem. Hawaiian coastal fisheries have plummeted nearly an order of magnitude over the last fifty years. These declines have resulted in a loss of recreational and subsistence opportunities for residents, as well as business opportunities for seafood and ocean recreation industries.

Goal: UH Sea Grant will provide science-based information to restore, conserve and sustainably use Hawai'i's diminishing nearshore and coastal resources with emphasis on raising awareness to empower the public, resource managers and legislators to cooperatively work together in solving these declining resource problems.

Meeting the Challenge:

Since its inception, UH Sea Grant and many partners have funded research and carried out extension activities aimed at solving our coastal resource declines. Despite these efforts, many questions remain and the majority of the public has little knowledge of the current status of our nearshore resources. Studies critically needed include those that define the existing resource base, ongoing impacts to that resource base (including the effects of fishing, influence of non-point pollution including the fate of anthropogenic materials in the near shore ocean, natural fluctuations, impact of alien species) and the management necessary for the improvement of the resource base (including enhancement, conservation, preservation strategies, appropriate extension and educational activities as well as conflict resolution). Public acceptance of any implemented resource management strategy is central to its success, thus a broad understanding of the issues and solutions is essential.

Achieving Results:

UH Sea Grant research and technology transfer has focused on pertinent questions regarding the impact of point source (i.e. sewage discharges) and non-point source (i.e. golf courses) pollution on coastal waters and marine resources. We have assisted the state in developing standardized sampling protocols and redefining Hawai'i's water quality standards. Many unique Hawaiian habitats and ecosystems, including coral reefs, are threatened by careless human actions. UH Sea Grant is defining human-induced impacts on these entities and assisting agencies in developing management strategies to protect these dwindling resources. Our extension efforts have also raised awareness of marine debris and its impacts. We have partnered with other federal, state and local agencies that have resulted in more than \$9 million in funding and removal of more than 280 tons of debris from beaches throughout the state and the Northwestern Hawaiian Islands.

New Strategies:

The result of much of the past work needs to be put into a context easily understood by the public. Research efforts also need to address many issues where information is currently inadequate. UH Sea Grant is in a unique position to participate in this collaborative research as well as to translate results for public consumption. Research aimed at developing successful education/extension strategies is needed that delineates how to best achieve public acceptance of research results and the management strategies implemented by those findings.

Objectives:

- G1. Develop more effective strategies for preventing the introduction and spread of potentially harmfully aquatic alien species.
- G2. Improve our quantitative understanding of nonpoint source pollution impacts on biological resources in our coastal waters.
- G3. Quantify the impacts of overfishing in our nearshore ecosystems.
- G4. Explore further use of community-based and local area management strategies as a means to manage our coastal resources.
- G5. Increase awareness of the declines and ecological changes occurring in our nearshore resources thus empowering the public, resource managers and lawmakers to create positive change in resource maintenance.

Benchmarks:

- Agencies will cooperatively work together, thus making better use of limited resources in solving alien species problems
- Studies will be completed that define the mechanisms responsible for the competitive superiority of many sessile aquatic alien species over native species, thus providing some predictability as to species, habitats and ecosystems at greatest risk to alien species invasion
- The effectiveness of the community-based fisheries management program in West Hawai'i will be understood
- An innovative education program focusing on Hawai'i's aquatic resources utilizing the television media will be in place reaching 20% of the population
- Culturally-sensitive conflict resolution protocols to address natural resource issues will be utilized by resource management agencies

• The impact that over-fishing and non-point source pollution have on nearshore marine resources will be sufficiently understood by managers, lawmakers and the public allowing them to take positive steps in controlling the most important of these impacts



H. Program Development

One can argue no state or region is in greater need of the products and services Sea Grant delivers than Hawai'i, isolated in the greatest ocean on earth. The state has recognized this by building its SOEST into one of the premiere institutions of its kind in the world. This, together with excellence in other University units provides a rich environment that possesses human resources with which to address the issues and opportunities that face a community and economy encompassed by coasts.

Goal: During 2003 – 2008, UH Sea Grant will aggressively explore all appropriate avenues to increase the budget for Sea Grant research and improve Extension personnel salary and career options.

A core NOAA budget differing little from that in 1980 demands creativity and "buy-in" from users and partners to deliver the quality and quantity of products and services Hawai'i requires. Indeed, research projects are fewer and smaller than in earlier times. In most cases, awards cover little more than graduate student support and supply costs. Nevertheless, we have been able to increase the buying power of funding in part because the faculty excellence our funding supports is at an all-time high. In the present biennium, we have expanded our capabilities in graduate education through the development of our Graduate Trainee Program. Among its many advantages is that as an education program, it carries a lower overhead rate than applied to graduate assistantships tied directly to research grant budgets.

We are thus able to support one to two additional graduate students than would otherwise be possible. We have augmented undergraduate education by more than \$575 thousand per year by obtaining competitive funding from NSF. Despite the reduced buying power of NOAA funds, UH Sea Grant research continues to attract high-caliber scholars to address the marine and coastal resource issues and opportunities central to Sea Grant's mission. Still, high priority issues and opportunities go un-addressed for lack of funding.

UH Sea Grant is blessed with an Extension staff and faculty of twenty-six creatively talented, dedicated and goal directed individuals. NOAA core budget supports just 4.9 full time equivalents (FTE). The Extension program is built with funding from partners and other federal and non-federal sources that support approximately 21 FTE. Extension personnel's dedication and core funding constraints leave them scrambling for funding, overworked, over-extended and underpaid. Specialists and agents must obtain a high proportion of their salary and operational support from projects compatible with the Sea Grant mission. These are facts-of-life that they face with ingenuity, determination and a positive, can-do sprit working cooperatively to meet common goals in a way that evokes humility and admiration from Program Administration.

This leveraging has allowed UH Sea Grant to continue to grow and address a greater number of issues. The need to fundraise is two-sided; connecting Extension staff to potential user clients and providing direct feedback on client and partner satisfaction. However, the time and effort required by Extension personnel to secure salary funding reduces energy available to focus on the primary Sea Grant outreach mission. Sea Grant Extension agents and specialists hold non-tenure academic positions. Year-by-year employment, coupled with the uncertainty of funding

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Habitats and Ecosystems

The deep waters of Lake Michigan support a rich ecosystem with a complex food web and a variety of habitats and species. Despite its vastness, however, the health of Lake Michigan, the Great Lakes, as well as nearby wetlands, rivers, and streams are vulnerable to threats posed by external forces. These threats impact the health of ecosystems as well as the fishery, other industries, and quality of life in the region.

Nonindigenous aquatic invasive species (AIS) such as the lamprey, alewife, and zebra mussel have tremendous impact on the Lake Michigan ecosystem and its reliant industries (e.g., commercial fishing, electrical power generation). Several of these species also threaten our inland waters. The potential introduction of additional species, such as the Asian carp, may have further environmental and economic impacts on the Lake Michigan region. Water users and resource managers require new methods to prevent future introductions and more environmentally friendly and efficient methods to control existing infestations.

Within the Illinois and Indiana coastal region of Lake Michigan, there are numerous areas where decades of industrial pollution have contaminated sediments. Current proposals for remediation of these toxic sediments are very expensive. A comprehensive assessment of the benefits of remediation is difficult and is needed in the Great Lakes region. Likewise, the restoration of rivers, streams, wetlands, and beaches requires careful planning and upto-date information.

Research Needed to Solve Contemporary Problems

- 1. Develop management solutions for specific fish species and their food resources in critical and sensitive coastal habitats.
- 2. Design solutions to decrease the impacts of contaminants, including complexing chemicals (e.g. toxins) on coastal and wetland communities.
- 3. Develop protocols, decision tools, techniques, and policy options to prevent the dispersal and introduction of existing and new invading species.

Goals

- Enhance the quality of the Lake Michigan ecosystem, inland aquatic systems, and the lives of coastal and shoreline residents by reducing the introduction, spread, and economic harm of AIS.
- Improve both the biological and human aspects of the Lake Michigan fishery through attainment, transfer, and application of knowledge concerning the lake's food web and ecosystem dynamics.
- Improve the health and abundance of valuable fish species.
- Reduce the ecological and economic impacts of contaminated sediments.



Outreach Objectives

1. By 2006, a model rapid response protocol for aquatic invasive species will be developed and adopted in Illinois.

IISG will work with the Aquatic Invasive Species Task Force, the Great Lakes Commission, and agency administrators in Illinois to work toward the adoption of the protocol.

2. By 2010, Indiana and Illinois will augment policies that prohibit possession of species (including those not currently in trade) that are capable of invading southern Lake Michigan.

IISG funded a study (Lodge and Kohler, 2004) that identified species most likely to invade the southern Lake Michigan ecosystem. IISG will work with the Aquatic Invasive Species Task Force and state AIS coordinators in Illinois and Indiana, agency managers, and interested stakeholder groups to consider the inclusion of these species in possession and trade policies.

3. Through 2010, the percentage of inland water recreational users that routinely practice precautionary steps to prevent the spread of AIS from their recreational activities will be maintained at 85 percent.

IISG will develop a variety of programs and products (based on latest research) for recreational water user audiences. Programs will include conferences for inland lake associations and presentations at sport and travel shows. Products will include Web site development for information sharing and reporting of AIS; development and placement of signs at boat ramps; fact sheets; and informational products designed for recreational water users that provide steps to reduce the spread of AIS. These last products will be delivered through bait, tackle, and boat dealerships; exhibits at state fairs; and farm progress shows. Questions appended to a creel survey that is conducted every two years will be used to monitor the percentage of recreational users routinely practicing precautionary steps to prevent the spread of AIS.

4. By 2007, 50 percent of trained agency sampling crews and conservation officers will incorporate HACCP (Hazard Analysis Critical Control Point) practices designed to reduce the introduction of AIS into Indiana and Illinois.

Workshops will be conducted in conjunction with inland lake association meetings and will be designed for conservation officers, sampling crews, researchers, and other personnel that move equipment from one water body to another. Participants will be trained to use HACCP procedures to reduce the probability of spreading AIS in our inland waters. Natural resource professionals that attend these training sessions will be surveyed approximately one year later to determine how often HACCP practices are incorporated into their daily procedures.

 By 2007, leading pet and aquarium dealers in Indiana and Illinois will become partners in the HabitattitudeTM campaign, thereby promoting responsible behavior to their clients that will help prevent the spread of AIS into natural ecosystems.

IISG will participate in a network-wide HabitattitudeTM project in partnership with U.S. Fish and Wildlife Service and the Pet Industry Joint Advisory Council. In addition, project personnel will work with leading pet and aquarium dealers in both states to become full partners in this nationwide information and education effort whereby vendors deliver these science-based products and messages to their customers.



6. By 2010, leading water garden suppliers in Indiana and Illinois will adopt management practices that help prevent the spread of AIS into natural ecosystems.

IISG will work with individual nurseries as a well as state nursery association representatives to distribute IISG-produced water garden materials and help them join the HabitattitudeTM campaign. Suppliers actively participating in the HabitattitudeTM campaign will document the adoption of management practices that help prevent the spread of AIS. Follow-up summative surveys, as required, will also be conducted.

7. By 2010, 500,000 researchers, students, and water users in 130 countries will access scientific publications and outreach products on AIS that are useful in their work and everyday lives.

IISG will partner with Wisconsin and New York Sea Grant to maintain and enhance the Sea Grant Nonindigenous Species (SGNIS) Web site for scientists, students, and water users. Additional partnerships with international AIS scientists will allow SGNIS to expand by adding literature written in other languages. New partnerships will also facilitate the transfer of research on U.S. native species to countries experiencing invasions of these organisms. Web usage will be documented through automated Web statistics using Web Trends software.

8. Through 2008, 50 natural resource professionals in Indiana and Illinois will annually receive the latest scientific information relative to stream restoration and dam management to assist in more effective restoration and management efforts.

IISG will partner with the Chicago Wilderness Consortium to conduct an annual conference that draws upon national experts who will present the latest scientific findings on stream restoration and dam management to natural resource managers in Indiana and Illinois. A steering committee composed of resource managers in both states will help identify key topics and organize the conferences.

9. By 2010, five communities in U.S. EPA's Great Lakes Areas of Concern will make informed decisions about contaminated sediment removal or management practices and will begin to implement selected steps.

IISG will work with GLNPO scientists to develop outreach products and programs designed to help communities assess their risk from contaminated sediments and to weigh management options that address the human health and ecosystem impacts of these contaminants. Facilitation will be provided and programs will be held in partnership with local citizen action groups in Areas of Concern who are considering Legacy funding to address sediment removal in their community. Community action in response to programming will be documented by response to and participation in the Legacy Program.



Education Objectives

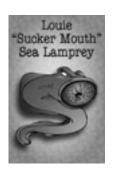
1. By 2010, over 50,000 families from the local area who visit Chicago museums and aquariums will have the knowledge to make behavior changes that help reduce the spread of AIS to our ecosystem.

IISG will partner with Chicago area museum exhibit planners to create and support activity stations that raise awareness of AIS problems and provide guidance on public action to prevent the spread and new introductions of AIS. Survey instruments will be created to measure resulting behavior changes.

2. By 2010, the Nab the Aquatic Invader! Web site will be accessed by 2,000 class rooms. As a result, teachers and students around the country will learn about issues related to AIS and 500 students will be empowered to develop community-based stewardship projects.

IISG will conduct teacher-training workshops in Illinois and Indiana and will partner with Sea Grant programs and educators in at least five other coastal states to develop new education activities for the Web site. In addition, the "Top 10 Suspects" list will be expanded to include aquatic invasive organisms from the Pacific, Atlantic, and Gulf coasts, as well as an enhanced component on freshwater aquatic invaders. IISG staff will also work with its partners to provide teachers with science-based information that allows them to help their students create community-based stewardship projects. Sea Grant, along with participating teachers, will present the Web site at national, regional, and state education conferences. Throughout the project, assessments will be developed to track the effectiveness of this instructional technology and to document community stewardship projects conducted by students inspired by the Web site.





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Personnel

Four technical specialists, two Web specialists, and an education specialist, comprising a total of 4.65 FTEs, contribute to this thematic area. In addition, three communications specialists and the outreach coordinator assist in program and product development. Outreach Objectives 1-6 will be led by the program's two aquatic invasive species specialists (0.45 FTE and 0.50 FTE). Objective 7 will be conducted by the program's chief Web officer (0.60 FTE) and Web technology specialist (1.00 FTE). Outreach Objective 8 will be conducted by our aquatic ecology specialist (0.75 FTE). Outreach Objective 9 will be led by the program's coastal sediment extension specialist (1.00 FTE). Education Objectives in this thematic area will be conducted by the program's education specialist and communications coordinator (0.80 FTE).



| Goal 2.2 | Strengthen leaders' | knowledge and | skills to under | gird the stabili | ty of coastal |
|----------|---------------------|---------------|-----------------|------------------|---------------|
| | communities. | | | | |

Objective 1. Develop decision-making and planning models for coastal communities undergoing rapid growth or decline.

Goal 2.3 Assist communities in mitigating coastal hazards

- Objective 1. Identify new resources for improving emergency preparedness and evacuation processes.
- Objective 2. Define the role of mitigation and community planning in coastal emergency preparations and response.
- Objective 3. Develop information on land use planning and building codes.
- Objective 4. Provide information relevant to rebuilding and recovery.
- Objective 5. Provide information concerning non-storm related hazards .

AREA 3. WETLANDS RESTORATION

Goal 3.1 Obtain a comprehensive understanding of changing coastal ecosystems in relation to sustainability of coastal resources.

- Objective 1. Develop and refine predictive modeling technology.
- Objective 2. Characterize socioeconomic implications of coastal restoration.
- Objective 3. Develop ecological metrics and design criteria for restoring wetlands that are functionally equivalent to natural ecosystems.
- Objective 4. Develop methodology for assessing health of wetlands.

Goal 3.2 Establish the academic research community as a major provider of applied research support for coastal restoration technology and programs.

- Objective 1. Develop plant materials for marsh creation and restoration.
- Objective 2. Develop public-private and university-agency partnerships.
- Objective 3. Improve coupling of academe and government with industry for commercialization of coastal restoration technologies.
- Objective 4. Develop performance metrics for coastal restoration projects.

Goal 3.3 Contribute to public awareness and understanding of sustainable development.

- Objective 1. Educate Louisiana residents about their relationship with the marine and coastal environments, and the need for conservation and restoration.
- Objective 2. Educate Louisiana residents about legal and regulatory aspects/implications of wetland protection and restoration.

AREA 4. WATER RESOURCES

Goal 4.1 Improve the quality of Louisiana coastal waters, reduce risks to public health and ecosystem productivity, and enhance water-based recreation and tourism industries.

- Objective 1. Develop and refine wastewater treatment technologies.
- Objective 2. Develop non-point source water quality education programs.
- Objective 3. Characterize the processes and rates of transport, fate, and effects of anthropogenic contaminants and pathogens.
- Objective 4. Develop methodology for detection, monitoring, prediction, and mitigation of harmful algal blooms.

Goal 4.2 Insure reliable sources of fresh water for sustainable coastal development.

- Objective 1. Participate in development of comprehensive water management policy.
- Objective 2. Develop and deliver educational programs for coastal audiences on water management.

Goal 4.3 Manage the introduction of nonindigenous aquatic nuisance species.

- Objective 1. Facilitate development and implementation of a state aquatic nuisance species management plan.
- Objective 2. Educate the Louisiana populace about invasive species and their effects on coastal ecology and local economies.
- Objective 3. Develop treatment technology for removal of nonindigenous aquatic nuisance species in ballast water.

AREA 5. PUBLIC AND FORMAL EDUCATION

Goal 5.1 Foster ocean literacy and comprehension of key marine and coastal issues.

- Objective 1. Deliver topical marine and coastal information to general and selected audiences.
- Objective 2. Advance environmental stewardship through teacher training and infusion of ageappropriate marine and coastal subject matter in the K-12 curriculum.

Goal 5.2 Maintain opportunities for baccalaureate and post-graduate students to acquire specialized scientific and technical knowledge of contemporary coastal and marine issues.

Objective 1. Provide opportunities for undergraduate and graduate students to make informed career decisions through marine-related training and work experience.

AREA 6. Non-Strategically Planned Projects

(This category is assigned to funded projects that do not fit into categories defined through the formal, four-year strategic planning exercise.)

Goal 6.1 Conduct cross-cutting projects.

- Objective 1. Conduct cross-cutting projects.
- Objective 2. Develop coordinating mechanisms to improve efficiency and performance of Louisiana's research establishment.

Goal 6.2 Support investigations in unplanned categories.

Objective 1. Conduct research projects in unplanned categories.

Strategic Plan, 2008-2012 >> Part II

Introduction | Part I | Part III

MIT Sea Grant Strategic Goals

- Playing a leading role in developing the infrastructure necessary for integrated marine processes modeling and measurement
- Exploiting marine animal behavior and ocean phenomena
- Supporting the development of critical technologies needed by the ocean research, educational, and commercial communities
- . Conducting research addressing fisheries, aquaculture, and water quality
- Developing food, pharmaceutical, and other commercial products based on marine natural organisms
- Educating our citizenry in the opportunities and challenges associated with continued expansion into the marine realm

Playing a Leading Role in Developing the Infrastructure Necessary for Integrated Marine Processes Modeling and Measurement

- Acoustic communication technology: MIT Sea Grant recognizes considerable technical opportunity in the area of ocean acoustics for communication and naviagation. Signal processing methods that enable reliable communications in the presence of acoustic channel distortion should focus on optimal exploitation of limited communication resources (bandwidth and energy). Research areas of interest include adaptive modulation/detection, efficient coding, array processing, and interference suppression in high-rate links and communication networks. Data compression methods that address sonar, seismic, and video signals are of interest. Maximal compression ratios, together with reliability and power consumption trade-offs must be addressed in the context of underwater sensing and imaging systems' requirements.
- Ease of remote data processing, archiving and distribution: As ocean and marine research becomes more synoptic and spatially expansive, the ability to easily access and visualize data and employ different modeling systems (such as those representing physical, biological, chemical and acoustical ocean phenomena) also becomes more important. This will assist in better oceanic phenomena prediction and improved assessment of natural and anthropogenic effects. Future research in this area includes dynamic data driven simulations combined with dynamic adaptive sampling methodologies and real-time data driven forecast systems in a distributed computing environment.
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Distributed networks and communication protocols: We encourage research that improves
access to and enables flexible use of distributed instruments in coastal and deep ocean
observatories. Research areas of interest include fundamental networking concepts that will provide
the basis for optimal resource allocation in the underwater environments, as well as design of
network protocols that specifically address application to ocean observation systems.

Exploiting Marine Animal Behavior and Ocean Phenomena

- Cetacean sonar locating and communication: Much can be learned from continued in-depth study of the sonar capabilities of certain marine life. The ability to locate prey and other creatures of the same species, as well as avoid obstacles in less than ideal conditions via sonar locating and interpretation is of great interest and application for ocean instrumentation and system concepts.
- Biomimesis-Learning from nature: During the last ten years we have supported research in the application of

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biomimesis-a process by which we design systems using principles employed by living organisms. This research track benefited greatly from the design and evaluation of scale models of fish noted for outstanding speed (the tuna) and for great maneuverability (the pike). New fluid mechanics mechanisms were discovered, governing the sensing and control of unsteady flows to achieve very high performance for marine craft. We are committed to studying the engineering aspects of biomimetics because this program will allow us to engineer AUV-type platforms with fish-like attributes and will help us further understand basic issues related to fisheries.



• Energy from the natural marine environment: Existing renewable sources of energy, such as windmills and solar power, provide energy with minimal impact to the environment. Many marine sources, such as current, tides and waves, can serve equally well as useful energy sources. Future research in this area includes studying the engineering aspects of extracting energy from these marine energy sources, and supporting their application.

Supporting the Development of Critical Technologies Needed by the Oocean Research, Educational, and Commercial communities

- The next generation of AUVs-enhancing capability through improved dexterity and perception: Exploring and working in the ocean remains a priority for the program. To fulfill this ambition, our challenge begins with designing the next generation of autonomous underwater vehicles. Such novel AUV incarnations will include crafts capable of hovering, vehicles that crawl and biomimetic creatures. Expanding the capabilities of these robots requires developing complementary sensing modalities and the required sensor technology, such as chemical and optical sensors, to achieve new mission objectives.
- Navigation and control theory and adaptive behavior: As the range and mission duration of autonomous platforms increase, the requirements of robust control and precise navigation are paramount for successful deployments. We have encouraged recent research efforts in new navigation algorithms that incorporate feature-based learning for an AUV to meet this challenge. Advanced modeling and control concepts are the crux of developing theory that will lead to robots making intelligent decisions on their own while operating in familiar or unknown environments. This research strategy emphasizes the need to further hone the applications of artificial intelligence in underwater robotic systems.
- Turbulence control: Understanding turbulence is one of the great ongoing problems in classical physics and a continuing grand challenge in hydrodynamics. Suppressing turbulence is key to solving a number of important engineering problems including frictional drag reduction in ships, elimination of noise in submarines, enhancement of acoustic communication between underwater vehicles, and efficient maneuvrability of all types of vehicles. A particularly attractive approach that takes advantage of the ocean water's electric conductivity is the use of electromagnetic excitation. Preliminary simulation and experimental work has shown a great promise in this technique but systematic work is required to develop suitable applications for the diverse applications of marine hydrodynamics.

Conducting Research Addressing Fisheries, Aquaculture, and Water Quality

- Address complex issues related to fisheries: MIT Sea Grant is committed to achieving and maintaining sustainability in fisheries and aquaculture through improved engineering of fishing systems, assessments of the economic and social impacts of regulations, increasing our understanding of the ecological significance of fishing and aquaculture, and developing better tools for determining the abundance and behavior of commercially important stocks. We are encouraging research that helps develop a comprehensive program for the successful integration of a commercial aquaculture industry in the Northeast.
- Investigate passive acoustics in fisheries research:

 The application of passive acoustics to fisheries is an example of an emerging research opportunity that also reflects the more general need for ocean observatories. Passive acoustics offers a unique tool not only to study fish, but also to simultaneously monitor sources of noise pollution and study the impact of man's activities on marine communities. Such research should also aid in management of commercially exploited species, improving techniques for identifying Essential Fish Habitat, and providing non-invasive methods for stock assessment.



Study coastal water quality and its impact on marine resource: The anthropogenic influences
on harbors and coastal waters have been a critical theme both for Sea Grant programs in
Massachusetts and throughout the nation. We are maintaining our focus on three important issues:
contaminated sediments, non-point source pollution, and marine accident prevention. We will be
encouraging scientific, engineering and policy research as it relates to responsible use of the coastal

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Crosscutting Issues

y paying attention to needs addressed by national, state and local partners, Maine Sea Grant can remain relevant to the issues of the day. More and more, these issues are requiring interdisciplinary collaborations that resist traditional boundaries, making it difficult for the Marine Extension Team to separate its work into theme areas, or "bins" as we frequently call them. Whenever we try to organize according to theme, we find that crosscutting issues force us to abandon our bins and work together to address the needs of our various constituencies. Over time, we expect that the divisions between theme areas will blur even more.



The Marine Extension Team works in four theme areas: fisheries, aquaculture, coastal communities, and ecosystem health. While the theme areas each have their own unique issues, all are being affected by the changes occurring along Maine's coast. Therefore, instead of describing the various issues and activities of the four theme areas, which has already been accomplished in previous strategic plans, annual reports, and program brochures, we have chosen to highlight how coastal changes have brought together extension team members from different theme areas to work on current, crosscutting issues: community-based natural resource management, planning for the future of coastal communities, sustainable seafood, and stewardship through citizen science.

"Whenever we try to organize according to theme, we find that crosscutting issues force us to abandon our bins and work together to address the needs of our various constituencies."

Here, we look at how these issues are affecting the state and how representatives of the different extension theme areas are responding as a team. Specific activities that address the needs related to these issues are discussed in the Implementation Plan.

Community-based Natural Resource Management

In recent years, as two national commissions have reported on the state of the oceans and single-species regulations to prevent overfishing have made headlines, ecosystem management has emerged as an alternative way to manage our ocean resources. As ecosystem-based management develops, communities have a role to play by participating in the research, stewardship activities, and decision-making process. Sea Grant is already working at the interface among scientists, policymakers, and the public and thus is optimally positioned to facilitate this participation, helping to create and ensure the use of the knowledge, tools, and skills needed for ecosystem-based management.

One example of local natural resource management is "bay management," which considers nearshore coastal waters as a whole ecosystem—including ecological, economic, and cultural conditions—not in terms of isolated species or uses. Maine's bay management study, initiated in 2004, encourages local input while recognizing that the state ultimately has responsibility for managing the waters in the public trust, those that lie within three miles of shore. Maine Sea Grant is represented on the Bay Management Steering Committee, which is examining the application of bay management principles to aquaculture and other activities. In 2005, several MET members helped to plan and facilitate five public meetings to receive input from citizens about nearshore water uses and conflicts. Insights from these workshops have helped inform the goals of this strategic plan.

Since the MET members are based where they work, they are in the right position to help coordinate bay management. They already know the stakeholders in the region, and have an awareness of each bay's environment, natural resources, and community dynamics.

Planning for the Future of Coastal Communities

"Many fear the loss of a fishing-based culture as coastal communities shift towards an economy based on suburban and second-home development, and tourism."

Throughout coastal Maine, industries have relied on waterfront infrastructure and the tradition of permissive trespass to gain access to the water. This historical access is being threatened by changes in land ownership and increasing diversity of water-dependent industries. Coastal communities and harbors are struggling to find the balance between newer businesses (schooners, kayakers, whale watchers, etc.) and traditional industries (lobster wharves, boatbuilding and other marine trades). As coastal real estate prices skyrocket and coastal landownership and attitudes change, the public is losing access to the shore. As a result, the overall size of the working waterfront is shrinking. Maine's coastal communities under pressure face potential economic loss, including lowered income or lost jobs for coastal families who rely on the water. Many fear the loss of a fishing-based culture as coastal communities shift towards an economy based on suburban and second-home development, and tourism.

The state is working to address the connection between coastal development and diminishing waterfront access. In 2003, Governor John Baldacci's Blaine House Conference on Maine's Natural Resourcebased Industries stated that the working waterfront (which includes aquaculture and other water-dependence)



Touring shellfish aquaculture sites.

Implementation Plan 2006-2008

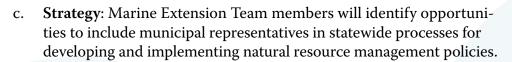
A. Community-based Natural Resource Management

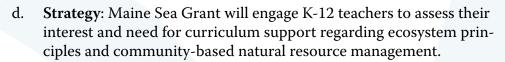
- -1. **Objective:** By 2010, the number of representatives from key stakeholder groups, such as the commercial fishing, aquaculture, transportation, and conservation sectors engaged in regional management of coastal natural resources will increase by 50%.
 - a. **Strategy**: Marine Extension Team members will include multiple stakeholder sectors in their target audiences for workshops, applied research projects, and stewardship programs.
 - b. **Strategy**: Marine Extension Team members will convene meetings and provide facilitation skills to engage multiple stakeholders in the process of developing natural resource management policy.
 - c. **Strategy**: Maine Sea Grant will expand mailing and contact lists to include multiple stakeholder sectors so that they will have access to communications products.
 - d. **Strategy**: Maine Sea Grant will recruit members for its Policy Advisory Committee from multiple stakeholder groups to broaden the perspectives considered in managing the program and to provide opportunities for these representatives to interact in a professional and informative setting.

Measure: The number of new representatives from multiple sectors participating in Sea Grant-sponsored activities.



- 2. **Objective:** By 2010, the number of communities participating in Maine Sea Grant-sponsored activities to foster public input in the development of natural resource policy will increase by 50%.
 - a. **Strategy**: Maine Sea Grant will identify appropriate municipal contacts for inclusion in program announcements and in distribution of communications products.
 - b. **Strategy**: Marine Extension Team members will build new relationships with community leaders in their region by inviting their participation in programs and committees.





Measure: The number of municipalities participating in Sea Grant-sponsored activities.

- 3. **Objective:** In each of three regions of Maine's coast, multiple towns will collaborate on natural resource management issues by 2010.
 - a. **Strategy**: Marine Extension Team members in southern Maine, midcoast Maine, and eastern Maine will conduct a needs assessment to gauge the level of inter-town cooperation on natural resource management.
 - b. **Strategy**: Based upon findings from the needs assessment, Marine Extension Team members will facilitate discussions between towns in their regions to encourage regional approaches to natural resource management.
 - c. **Strategy**: Marine Extension Team members will participate in follow-up activities related to bay management and will facilitate community inclusion in regional bay management initiatives.
 - d. **Strategy**: Maine Sea Grant will include social science investigators in recruiting for research projects on natural resource economics, governance and other sociological themes to provide a scientific basis for community inclusion in natural resource management.

Measure: Number of municipalities engaged in regional natural resource management initiatives.

Strategic Issue Areas Sustainable Coasts

Coastal development pressures in Michigan will continue to expand in the amount, type, and intensity of conflict. Coupled with the decline of some traditional coastal business sectors, addressing these pressures requires increasingly complex decisions. Market forces are driving coastal development into sectors that reap the highest economic value, often at the expense of sustainable coastal use. Many of these coastal development issues are compounded by both ecosystem alterations in coastal watersheds and a growing set of aquatic ecosystem issues, including the introduction and spread of invasive species, pollution inputs from diverse sources, and the alteration of essential coastal habitats.

Recognizing the integrated nature of coastal issues, Michigan Sea Grant has selected the theme of sustainable coasts as the framework for strategic initiatives over the next five years. Sustainable coasts provide economic opportunity and a high quality of life while ensuring the long-term viability of the State's natural coastal resources. Michigan Sea Grant will focus research, outreach, and education programs on those critical drivers of change that influence the region's ability to achieve sustainable coasts. These include the effects of aquatic invasive species, the aspirations of coastal communities, fluctuations in fisheries, changes in water quantity and quality, and the protection and restoration of coastal aquatic habitat.

Strategic Focus: Primary and Developing Issues

This strategic plan focuses on five primary issues: Aquatic Invasive Species, Coastal Communities and Economies, Fisheries, Coastal Aquatic Habitat, and Marine and Aquatic Science Literacy. Recent trends have heightened concern among Sea Grant stakeholders about two additional areas for which Michigan Sea Grant will also develop increased programmatic emphasis over the coming years – water quantity and water quality. However, these developing issues will be treated within the five primary issue areas.

In the area of water quantity, Michigan Sea Grant will continue to work with coastal landowners and resource users to inform them about the causes and consequences of lake level fluctuation and how to manage their use of the resource to moderate the impact of lake level changes on coastal businesses and economies. The impact of rapid fluctuation in water levels, most recently seen in close to historic low lake levels, has highlighted the need for additional research, outreach, and education. Water quantity issues will be addressed primarily within the context of Coastal Communities and Economies.

In the area of water quality, Michigan Sea Grant will continue to work on the issue of contaminated sediments and their ecosystem impact (e.g., fish consumption advisories). However, interest in remediation of contaminated sediments, limiting polluted run-off, restoring water quality, and understanding the influence of invasive species on harmful algal blooms requires increased effort here as well. While it is evident that water quality affects all of the strategic issue areas, it will be highlighted within the context of Coastal Aquatic Habitat, and Coastal Communities and Economies.

A common theme across these issue areas is security, which includes ensuring ample clean and affordable water resources for the economic and environmental benefit of society and encompasses the issue areas identified in this strategic plan.

Michigan Sea Grant's strategic plan corresponds with national priorities identified by both the National Sea Grant Program and its parent agency NOAA. Chart one on the following page demonstrates areas where the Michigan Sea Grant strategic plan overlaps with National Sea Grant priorities. It is also important to note that Sea Grant programs nationwide have developed theme teams of experts in issue areas of national importance. Michigan Sea Grant participates on and collaborates with those theme teams where appropriate. Finally, chart two on the following page outlines where Michigan Sea Grant's strategic areas match NOAA's mission, goals and strategies, another indicator of the program's integration into national priorities.

Strategic Issue Areas of Michigan Sea Grant, NOAA and National Sea Grant College Program

| Michigan Sea Grant Strategic Issue Areas | | | | | | | |
|--|-----------------------------------|--|----------------------------|-----------|-----|--|--|
| Chart One: NOAA National Sea Grant Theme Areas | Coastal Communities and Economies | Marine and Aquatic Science Literacy | Coastal Aquatic Habitat | Fisheries | AIS | | |
| Aquaculture | • | • | | • | • | | |
| Bio-technology | | • | | | | | |
| Coastal Communities | • | • | • | • | • | | |
| Coastal Hazards | • | • | • | | | | |
| Digital Ocean | • | • | • | • | • | | |
| Ecosystems and Habitats | • | • | • | | • | | |
| Fisheries | • | • | • | • | • | | |
| Marine Science Literacy | • | • | • | | | | |
| Seafood Science | • | • | | • | | | |
| Urban Coasts | • | • | • | • | | | |

Chart Two: NOAA Mission Strategies

| NOAA Mission Goals | Monitor & Observe | Understand & Describe | Assess & Predict | Engage, Advise & Inform |
|--------------------------------|-------------------|--|---|--|
| Ecosystems | AIS | AIS; Fisheries; Coastal Aquatic Habitat; Marine and Aquatic Science Literacy | AIS; Fisheries; Coastal Aquatic Habitat; Marine and Aquatic Science Literacy | AIS; Fisheries; Coastal Aquatic Habitat; Coastal Communities and Economies; Marine and Aquatic Science Literacy |
| Climate | | Fisheries: Coastal Aquatic Habiat; Coastal Communities and Economies | Coastal Communities and Economies | Coastal Communities and Economies; Coastal Aquatic Habitat; Marine and Aquatic Science Literacy |
| Weather and Water | | Coastal Communities and Economies and Coastal Aquatic Habitat | AIS; Fisheries; Coastal Communities and Economies; Coastal Aquatic Habitat | Fisheries; Coastal Aquatic Habitat; Coastal Communities and Economies; Marine and Aquatic Science Literacy |
| Commerce and Transportation | AIS | AIS; Coastal Aquatic Communities | | AIS; Fisheries; Coastal Communities and Economies; Marine and Aquatic Science Literacy |

Aquatic Invasive Species

Aquatic invasive species (AIS) are serious threats to the Great Lakes ecosystem. Non-native invertebrates, fish, and plant species enter the system through a variety of vectors, become established in Great Lakes region, and disrupt food webs. Invasive species have caused significant ecological harm as they alter ecosystem structure and function. Species such as water fleas, zebra mussels, sea lamprey, and purple loosestrife, have had significant ecological and economic impacts in the region. Many AIS affect industrial and municipal infrastructure, the health of important commercial and sport fisheries, and other vital social and economic activities. Preventing the introduction and controlling the spread of AIS, as well as mitigating their negative impacts costs the region hundreds of millions of dollars annually.

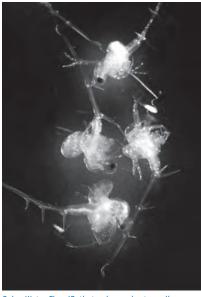
Goal:

Michigan Sea Grant will support research, outreach, and education to prevent the introduction of new aquatic invasive species into the Great Lakes, control the spread of established invasive species, and mitigate their ecological and socio-economic impacts.

Issues:

- Imminent introductions of new species;
- Predicting new invaders;
- Understanding dispersion vectors and controlling spread;
- Ecosystem impacts;
- Social and economic impacts;
- Effective outreach to control spread;
- · Mitigation strategies; and
- Lack of AIS curricula in Michigan schools.

- Coordinate university-based and government AIS research in Michigan; support multidisciplinary research related to the spread, control, and mitigation of AIS, and to understand their ecological, social, and economic impacts; support development of methods for improved AIS detection and monitoring.
- Collaborate with appropriate partners to develop appropriate responses to potential and new invasions using state of the art technologies; and raise awareness, and develop knowledge and skills related to AIS among stakeholders and the public via extension, events, publications, website, and media campaigns.
- Strengthen collaborations to develop, disseminate and facilitate use of AIS educational materials directed to K-16 students and teachers, as well as other nonformal education opportunities.



Spiny Water Flea (Bythotrephes cederstroemi)

Coastal Communities and Economies

Michigan land use decisions are made at the local level – city, township, and village – where there is often little understanding of the complexity of the entire coastline and even less awareness of the cumulative impacts of individual land development choices on the Great Lakes. A steady growth of permanent and seasonal residents near the Great Lakes has produced a substantial increase in the use of coastal areas for business, recreation, and residential purposes. Managers with responsibility for coastal development must recognize several principles of sustainability. These include: coastal economies are interrelated with social structures and ecosystems; the intensity of coastal development can have a significant impact on the sustainability of the coastal ecosystem; and sustaining coastal communities will require long-term ecologically and socially sound management practices.

Within the context of supporting coastal communities, there is a special need to address capacity to deal with natural lake level fluctuation. The relatively rapid change from historic highs in the mid-1980s to near historic lows in 2002 highlights the need for communities to plan and design around extremes. Similarly, the economic health of Michigan's coastal communities is dependent upon access to ample clean and affordable water resources, as well as public beaches and resorts where water-based recreation is regularly safe to undertake. Michigan's long-term ecological and economic health depends upon the protection and scientifically based management of Great Lakes water resources.

Goal:

Michigan Sea Grant will make significant contributions to research, outreach, and education that lead to sustainable coastal economies, communities and ecosystems, including understanding the impacts of natural fluctuations, diversions, and consumptive uses of Great Lakes water.

Issues:

- Economic sustainability for coastal businesses;
- Limited recreational access to waterfront;
- Safety/security of coastal infrastructure e.g., harbors, water intakes;
- Placement and maintenance of commercial and recreational harbors/marinas;
- Human impacts on coastal systems e.g., through land use and water withdrawal;
- Climate change;
- Understanding the legal framework related to water rights and regulations; and
- · Preserving historic and traditional uses of waterfronts.

- Support research on land use planning, law/business/economic issues, and public policy options to promote sustainable coastal economies; support assessments of the ecological implications of fluctuating lake levels.
- Lead efforts, involving diverse stakeholders, to design sustainable coastal community development programs incorporating coastal
 aquatic habitat, water-dependent uses and brownfield redevelopment issues; identify opportunities and work with harbor and port
 stakeholders on economic, security and transportation issues.
- Provide information on lake level fluctuations to coastal residents, business owners and resource users, and develop, disseminate and facilitate use of K-12 curriculum materials and carry out public awareness campaigns that highlight related ecological and economic issues and stewardship practices.

Fisheries

Great Lakes fish ecosystems are arguably the most important freshwater fish ecosystems in the world, ones that support a multibillion-dollar sport fishery, tribal subsistence fisheries, and a valuable commercial fishery. Ecosystem stressors, such as aquatic invasive species, improper land use, fluctuating nutrients, over exploitation, and disease, challenge the integrity of the Great Lakes fisheries. As a result, their vitality is one of the more visible indicators of the overall health of our Great Lakes, both ecologically and economically. The regeneration of Great Lakes fisheries is often linked to an economic renaissance of the associated coastal communities, and as one of Michigan's original industries, it is an important cultural and historic link to our Great Lakes heritage, including that of the Native American tribes.

Goal:

Michigan Sea Grant will support research, outreach, and education efforts about the Great Lakes fish ecosystems; contribute information that promotes sustainable fisheries; and support those stakeholders and communities that are fishery dependent.

Issues:

- Economic viability of sport and commercial fishery;
- Impact of aquatic invasive species on the fishery;
- Native species restoration;
- · Fish habitat degradation and rehabilitation; and
- Fish recruitment and production dynamics.



Sea Grant promotes sustainable fisheries and works with stakeholders on recreational and commercial fishing issues.

- Support research to enhance the understanding of fish ecosystem rehabilitation, enhancement, and production, and fishery-related issues including: understanding recruitment dynamics and management strategies; the impact of invasive species on food web dynamics and fish populations; and the relationship of habitat productivity to fish health, production, and rehabilitation.
- Work with commercial, tribal, and sport fishers to adopt practices based on sound science, facilitate stakeholder consensus, and lead efforts to enhance and promote the economic viability of Michigan's Great Lakes fisheries.
- Identify fisheries educational opportunities for K-12 students, teachers, and the public and provide education and training for emerging fishery leaders; provide economic impact data on Great Lakes fisheries to decision-makers.

Coastal Aquatic Habitat

Coastal aquatic habitat includes wetlands, coastal sand dune systems, drowned river mouths, reef complexes and near-shore spawning and nursery areas for fish and wildlife. Human activities and natural events, such as fluctuating lake levels and shoreline alteration, affect the quality and quantity of coastal habitat that, in turn, affects ecosystem health and well-being. Understanding how human activities affect coastal aquatic habitat and magnify the impact of natural processes is critical to the ecological and economic health of Michigan's coasts and their embedded natural resources.

Water quality continues to be one of the more significant issues affecting aquatic habitat in the Great Lakes basin, as well as impacting human use, health and the productivity of Great Lakes ecosystems. These, in turn, affect the economic and social well being of coastal communities and businesses, which are reliant upon clean water and healthy fish and wildlife populations.

Goal:

Michigan Sea Grant research, outreach, and education will contribute to our understanding of the impact of human activity on coastal aquatic habitat and Great Lakes water quality, and assist in the development of policies and programs with the citizens of Michigan and local, state, and national management agencies that protect valuable coastal habitat.

Issues:

- Habitat restoration to support ecologically, economically and socially important species;
- Assessment of the ecosystem values of restored/constructed habitats;
- Non-point source pollution and sedimentation;
- Human impacts on coastal aquatic habitat and water quality; and
- Pathogens and toxins in drinking and recreational waters.

Sea Grant works to analyze the impact of human activities on Michigan coastal habitat.

- Support multidisciplinary research that determines the short and long-term impact of human disturbances on coastal habitat; develops and evaluates best management practices for the rehabilitation of water quality and coastal habitats for the benefit of aquatic organisms and humans; and identifies and evaluates policies, programs, and strategies for targeting and reducing non-point sources of pollution and addressing contaminated sediments.
- Work with appropriate federal, state, tribal, and other partners to develop and continue programs that address significant coastal habitats to restore, protect, and enhance biodiversity.
- Disseminate and facilitate use of existing K-16 and public educational materials to increase awareness of the basin's biological diversity and human impacts on the Great Lakes ecosystem.

ECOSYSTEMS AND HABITATS

Outreach Contacts: Cindy Hagley, Doug Jensen and Barb Liukkonen

GOAL:

Design and implement a comprehensive research and outreach program to promote a balance between economic growth and coastal resource quality for healthy coastal communities and coastal ecosystems. This goal includes:

 Describing and modeling the dynamics, fate, and ecological effects of toxic contaminants in Lake Superior.

Facilitating formulation of appropriate natural resources public policy.

• Examining environmental and economic impacts of exotic species and developing control techniques, including preventing expansion of range from Great Lakes to inland waters.

• Developing predictive models and improved qualitative and quantitative understanding of coastal and inland ecosystems, habitats, and biotic communities.

CHALLENGE:

Lake Superior, although relatively pristine and known for exceptional water quality and quantity, faces similar problems from point and nonpoint sources of pollution as the other Great Lakes. Lake Superior's ecosystems and habitats are threatened or already stressed by human activity and by the proliferation of aquatic invasive species, particularly in the Duluth Superior Harbor. At the same time, this unique international resource remains the least well understood of the Great Lakes.

Areas of interest to Sea Grant include ecological indicators and assessment tools; contaminant fate, effects, and risk assessment techniques; global climate and lake level impacts on ecosystem structure and function. Also of interest are ecological risks and control methods for invasive plants and animals; and impacts of coastal land uses on Lake Superior ecosystem structure and function. Studies of basic ecosystem function, including food web dynamics and coastal ecology, could fill critical gaps in our understanding of this unique ecosystem.

SPECIFIC RESEARCH PRIORITIES AND EMERGING ISSUES:

Describing and modeling the dynamics, fate, and ecological effects of toxic contaminants in Lake Superior:

• Determine the sources, effects, and bioavailability of contaminants, including metals and endocrine disrupters, on fish, wildlife, and humans.

 Develop bioremediation or ecological engineering solutions to environmental contamination problems.

 Develop defensible, practical analytical techniques for lowering detection limits for contaminants in water.

Examining environmental and economic impacts of exotic species and developing control techniques, including preventing expansion of range from Great Lakes to inland waters:

 Develop advanced technological or other innovated approaches to control aquatic invasive species.

• Develop zebra mussel control demonstration projects for water systems. Developing predictive models and improved qualitative and quantitative understanding of coastal and inland ecosystems, habitats, and biotic communities:

 Develop better models for estimating the impacts of human activities, including climate change, on water and habitat quality.

- Develop better energetics modeling for the biotic communities in Lake Superior.
- Determine the ecological interrelationships among exotic and endemic species.
- Examine cumulative impacts of human activities, such as hydrological problems caused by loss of small wetlands and Gulf of Mexico hypoxia from agricultural impacts.

IDENTIFIED OUTREACH PRIORITIES:

Facilitating formulation of appropriate natural resources public policy:

- Improve recognition of the value of pristine environments and the lesser costs associated with preserving pristine environments versus the greater expense required to restore degraded environments.
- Improve understanding of the impacts of increasing tourism on ecosystem structure and function.

Examining environmental and economic impacts of exotic species and developing control techniques, including preventing expansion of range from Great Lakes to inland waters:

 Educate and change the behavior of water related users so that they prevent the spread of aquatic invasive species into new water bodies.

Developing predictive models and improved qualitative and quantitative understanding of coastal and inland ecosystems, habitats, and biotic communities:

- Educate the general public and specific Great Lakes audiences about practices and recommended strategies to counter or react to climate change.
- Improve public understanding of Total Maximum Daily Loads and watershed approaches to managing nonpoint sources.

MARINE AND AQUATIC SCIENCE LITERACY

Outreach Contact: Bruce Munson

GOAL:

Identify critical influences on marine and aquatic science literacy and determine ways that Sea Grant educators can have the greatest positive influence toward developing a scientifically literate U.S. population. This goal includes:

- Developing new technologies and translating research results to make them easily accessible and understandable to the general public.
- Developing better methods for reaching adults and young professionals with marine and aquatic literacy initiatives.
- Developing and conducting workshops for teachers to train them in the use of curricula developed to address marine and aquatic literacy.
- Coordinating marine science education programs with other educational institutions in the Great Lakes region and beyond.

<u>CHALLENGE:</u>

Delivering sound, practical science to a variety of audiences in a meaningful way is critical for long-term economic and environmental sustainability. Well-reported science and technology news not only encourages environmental stewardship, but also attracts more public and private support for research and attracts interested, talented students to careers in science. Many people have limited exposure to scientifically accurate information relevant to their daily lives.

Priority Thematic Areas

The MASGC will address five priority theme areas: (1) Health and Restoration of Coastal Habitats; (2) Coastal Community Resiliency and Resource Management; (3) Seafood Safety and Processing Technology; (4) Fisheries Ecology and Aquaculture; and (5) Marine Education. Through an integrated approach with research MASGC utilizes its core education and outreach (communications, extension, and legal) programs in cross-cutting strategies to address each strategic area. Each priority theme area is organized around three general categories including what is to be accomplished (goals), what needs to be done to get there (objectives milestones), and how to measure progress (outcomes and performance measures).

Priority Theme Area 1. Health and Restoration of Coastal Habitats

Goal

To reduce nonpoint source pollution and increase the use of improved technologies and techniques for creation, enhancement, and restoration of estuarine habitats.

Setting

In Alabama and Mississippi, Perdido Bay, Mobile Bay, and the Mississippi Sound are important estuaries representing a total surface area of 5,981 km². Mobile Bay and the Pascagoula River drainage basin in the Mississippi Sound are of special concern to MASGC. The 480-square-mile Mobile Bay estuary contains a documented 337 species of fish, more species per area than any other region of North America. Of the 74 major river estuaries in North America, the Pascagoula River is the only one in the United States that remains unaffected by channel fragmentation and flow regulation along its entire length. As a result, the Pascagoula River is a vital center of biodiversity and essential fish habitats for numerous threatened and endangered species.

The anthropogenic impact on estuarine ecosystems has led to a decline in total acreage of habitat. Estuarine ecosystems, such as salt marshes and other wetlands, seagrass meadows, oyster reefs, and tidal basins, physically protect coastlines, provide essential habitat, and filter nutrients and other pollutants that degrade water quality and adversely affect overall ecosystem health. Estuaries provide critical habitat for numerous species of commercially and recreationally important waterfowl, migratory birds, marine mammals, and sea turtles. The decreased area and fragmentation have led to a decline in the essential ecological benefits provided by these habitats. In recognition of the importance of sustaining healthy estuarine habitat, the Estuary Restoration Act of 2000 called for a national strategy with a goal of restoring 1-million acres of estuarine habitat by 2010. Several areas of research are necessary to meet this goal. Research programs that address on-the-ground restoration projects are needed to apply appropriate restoration science and technology to project design, implementation, and evaluation.

Strategic Actions

MASGC will support integrated research, education, and outreach programs to:

- 1. Determine market and non-market valuation of coastal resources.
- 2. Determine environmental benefit-cost analysis of restoration strategies.
- 3. Determine the impact of nonpoint source pollution on estuarine ecology (wetlands, marshes, seagrasses, or shellfish communities).
- 4. Develop methods to control or abate nonpoint source pollution.
- 5. Develop methods to minimize impacts of wastewater treatment plants using constructed wetlands.
- 6. Determine the effectiveness of erosion control technologies and alternatives.
- 7. Develop and assess estuarine restoration strategies.
- 8. Develop predictors of the effects of habitat fragmentation on living marine resources.
- 9. Develop predictors that link land-use planning to the health of coastal watersheds and minimize adverse impacts on water quality.
- 10. Assess living resources' responses to environmental stress or pollution.
- 11. Provide leadership in improving water quality and producing oysters to assist in restoration efforts through the Mobile Bay Oyster Gardening Program.
- 12. Conduct education programs by disseminating research-based information on non-point source pollution, estuarine restoration, and watershed management to agency leaders, elected officials and those who live in coastal communities.
- 13. Provide leadership in designating and prioritizing conservation and restoration areas.
- 14. Test and implement alternatives to shoreline erosion control devices such as seawalls and bulkheads.
- 15. Analyze and disseminate information about the existing and potential legal and policy strategies to protect estuarine habitats and other coastal ecosystems.
- 16. Coordinate pollution reduction programs including the Clean Marina and marine debris programs.

Objectives

- Improvements in water quality and health of coastal watersheds will be achieved through a better understanding of ecosystem system components and by adopting new technologies derived through MASGC-supported research and outreach.
- 2. Fifty acres of estuarine habitat will be created, restored, or enhanced using techniques developed through MASGC sponsored research or outreach.
- 3. Increase the number of new and provide support to existing volunteers participating in the volunteer restoration program.
- 4. Five new marinas will join the Alabama and Mississippi Clean Marina program.
- 5. Two shoreline protection alternatives will be implemented in coastal Alabama and Mississippi.

- 6. Over 3,000 members of special interest groups such as Realtors and educators, as well as schoolchildren and the general public, will gain a better understanding of issues pertaining to habitats and water quality in the coastal region.
- 7. 2,000 coastal residents will increase their knowledge about the ecological and economic dangers posed by aquatic nuisance species (ANS).

Expected Outcomes and Performance Measures

Expected outcomes are organized into the three areas of performance.

- 1. Return on investment from the discovery and application of new sustainable coastal and ocean products.
 - a. Improved restoration strategies achieved through improved technologies for use by managers, non-profit organizations, and environmental consulting firms.
 - b. Increased resiliency of estuarine habitats through adoption of improved restoration technologies.
- 2. Cumulative number of coastal, marine, and Great Lakes issue-based forecast capabilities developed and used for management.
 - a. Number of tools developed to achieve a better understanding of interactions between estuarine habitats and nonpoint source pollution.
 - b. Number of tools developed to predict the effects of land-use planning on estuarine habitats.
 - c. Number of tools developed to evaluate effectiveness of restoration strategies.
 - d. Number of predictors of environmental stress on coastal ecosystems.
- Percentage/number of tools, technologies, and information services that are used by NOAA Sea Grant partners/customers to improve ecosystem-based management.
 - a. Graduation, placement and recognition of undergraduate and graduate students and their contribution of theses and dissertations.
 - b. Number of top-ranked publications and citation frequency.
 - c. Patents and licensed technologies.
 - d. Number of needs-based outreach events/publications
 - e. Partnerships developed in support of priority areas.

Priority Theme Area 2. Coastal Community Resiliency and Resource Management

Goal

To provide economic leadership in maintaining a balance between coastal development and historical activities in coastal communities.

- b. Decrease in fines and other regulatory actions imposed on processing facilities.
- c. Development of value-added products derived from seafood-processing wastes.
- 2. Cumulative number of coastal, marine, and Great Lakes issue-based forecast capabilities developed and used for management.
 - a. Extent of use of rapid detection methods for shellfish by health agencies and industry.
 - Number of tools identified to predict oyster safety and potential for disease outbreak.
- Percentage/number of tools, technologies, and information services that are used by NOAA Sea Grant partners/customers to improve ecosystem-based management.
 - a. Graduation, placement and recognition of undergraduate and graduate students and their contribution of theses and dissertations.
 - b. Number of top-ranked publications and citation frequency.
 - c. Number of patents and licensed technologies.
 - d. Number of needs-based outreach events/publications.
 - e. Number of partnerships developed in support of priority areas.

Priority Theme Area 4. Fisheries Ecology and Aquaculture

Goal

To improve the sustainability of the commercial and recreational capture fisheries and aquaculture including stock enhancement through research and outreach programs.

Setting

The commercial fishing industry is very important to the economies of Alabama and Mississippi. Recreational fishing is also a significant driver of the economies of both states. The 2001 economic output from saltwater fishing in Alabama was valued at \$463 million, and in Mississippi it was valued at \$98 million. The saltwater recreational angling industry has created more than 6,000 jobs. Most of the Gulf of Mexico's economically important marine fish and invertebrate species are heavily exploited, The continued presence of normal and healthy population numbers substantially relies upon healthy and sufficient estuarine and nearshore coastal habitats and ecosystems.

Fishery products are a chief source of protein globally. Some estimates suggest that 20 percent of the world's protein is derived from fish. In 2004, per capita seafood consumption in the U.S. achieved a record level of 16.6 pounds. The 16.6 pounds per person per year does not account for seafood caught and consumed by recreational anglers. Data from a 2005 survey demonstrated that these anglers and their families may consume an additional 20 pounds of seafood per year. Seafood imports contribute to our federal trade deficit with over \$8 billion in 2004. These imports account for more than 75 percent of the total seafood consumed. The enormous and ever-increasing

demand for seafood is obvious. However, in response, the U.S. is unlikely to expand current domestic commercial harvests substantially.

The U.S aquaculture industry is valued at nearly \$1 billion in products annually from both fresh and saltwater farms and employs about 200,000 people. For aquaculture development to proceed to the level where it is recognized as a major contributor to new agricultural production, clear, fervent, unambiguous linkages between aquaculture and the environment must be created and fostered. The multiple and complementary roles of aquaculture as a contributor to marine natural product development, source of organisms for medical research, fisheries sustainability, rehabilitation and restoration, and enhancement must be successfully articulated to a highly concerned, increasingly educated, and involved public.

Strategic Actions

MASGC will support integrated research, education, and outreach programs to:

- 1. Develop predictors of ecosystem health using fishery models.
- 2. Collect fundamental life history and behavioral information on recreational and commercially important species.
- 3. Assess the role of forage species on the populations of commercial and recreational species.
- 4. Identify critical spawning and nursery habitats of NOAA defined trust resources.
- 5. Evaluate technology for and economic feasibility of marine aquaculture enterprises, including land-based hatchery and nursery support systems.
- 6. Determine the impacts and develop technologies to reduce introductions and minimize the impacts of invasive species on biodiversity and estuarine community assemblages.
- 7. Increase the public's awareness of ecosystem management and essential fish habitat issues and provide well-documented, comprehensive, and accurate information on the feasibility of marine aquaculture.
- 8. Provide leadership in engaging the Asian ethnic groups in fisheries issues.
- 9. Provide technology transfer for nearshore and offshore aquaculture.

Objectives

- 1. One commercially manufactured sea urchin feed will enter the marketplace.
- 2. One new predictive fishery model will be developed.
- 3. The ecological role of gray triggerfish on artificial reefs will be determined.
- 4. Bait production technologies, economics and marketing will be developed that leads to better economic return for four bait dealers and the creation of one new bait businesses.
- 5. At least 50 high school teachers and 250 students will participate in aquaculture training or classes.
- 6. Over 3,000 recreational and commercial fishermen, environmentalists and other interested parties will increase their understanding of natural resource issues

- such as essential fish habitat, marine reserves, the "precautionary approach" in fisheries management, limited entry, and individual transferable quotas.
- 7. Fisheries bycatch will be reduced in Mississippi-Alabama coastal and offshore fisheries. Fishermen will learn techniques to reduce fuel consumption and concomitant operating costs.

Expected Outcomes and Performance Measures

- 1. Return on investment from the discovery and application of new sustainable coastal and ocean products.
 - a. Number of new product lines for the aquaculture supply industry.
 - b. Number of new aquaculture businesses using new technologies or techniques (food and bait).
 - c. Increased return on investment by commercial and recreational fishing industries through adoption of new technologies or techniques.
- 2. Cumulative number of coastal, marine, and Great Lakes issue-based forecast capabilities developed and used for management.
 - a. Number of predictors developed to estimate long-term health of fisheries.
 - b. Number of predictors developed to aid in siting marine aquaculture enterprises
- Percentage/number of tools, technologies, and information services that are used by NOAA Sea Grant partners/customers to improve ecosystem-based management.
 - a. Graduation, placement and recognition of undergraduate and graduate students and their contribution of theses and dissertations.
 - b. Number of top-ranked publications and citation frequency.
 - c. Number of patents and licensed technologies.
 - d. Number of needs-based outreach events/publications
 - e. Number of partnerships developed in support of priority areas.
 - f. Number of K-12 aquaculture programs developed.

Priority Theme Area 5. Marine Education

Goal

To give citizens, coastal managers, teachers, and the nation's youth the training and experiences that will help them make connections between ocean science information and decisions about coastal and ocean resources.

Setting

Education and outreach are two of MASGC's core program areas. Continuity of these programs is essential to their long-term success. The key to achieving success of these programs is matching theme areas with staff expertise. MASGC education and outreach staff have demonstrated experience in one or more of MASGC's theme areas. Operationally, staff implements programs by focusing on priority objectives as defined in

- Considering alternative sources of energy and water for coastal communities and the environmental consequences of implementation;
- Determining the economic and cultural impact of recreational and commercial fisheries on coastal communities and economies;
- Defining parameters needed to support nature- and heritage-based tourism and quantifying the economic impact of such activities; and
- Understanding the policy, environmental and economic implications of public-trust resource allocation and use.

Coastal Natural Hazards

The edge of the coastal ocean, including its barrier islands, is exposed to a host of hazards — including storms, hurricanes, oil spills and erosion. Coastal development and infrastructures are vulnerable, and large social and economic losses often follow such events. Better environmental policies are needed to guide coastal communities in predicting, and dealing with, coastal hazards. Also, communities need to understand how underlying geological frameworks influence coastal processes.

Priority research and outreach goals include:

- Determining the impacts of geologic dynamics of the shoreface, inlets, estuaries, sounds, wetlands and barrier islands on erosion rates and land use:
- Evaluating the latest long-term and stormrelated erosion prediction methodologies for hazard identification and management strategies;
- Determining and developing hazard-based community information and vulnerability indices;
- Developing the criteria for risk analyses of buildings and other development, evaluating building code standards, and developing technologies to meet and exceed the standards;
- Quantifying interactions between barrier island/estuarine dynamics and increasing coastal development, then translating the results into economic models;
- Informing decision makers and the general public on the role of geologic and hydrologic processes in various land uses, erosion and

- shoreline changes, and coastal resource response to storms; and
- Working with local officials and other partners to identify beach safety priorities and developing outreach efforts to reduce risk of injury or death.

Digital Ocean

Models must be created to enable the translation of chemical, biological and physical data into tools that will help the nation learn how to best use and maintain the integrity of its marine resources. These new technologies will support emerging national efforts to integrate ocean observations and coastal monitoring.

Priority research and outreach goals include:

- Developing coastal ocean observing information tools useful to nonscientists;
- Preparing communities, government agencies and citizens for extreme weather and climate events;
- Quantifying surface and underwater currents and their transport functions; and
- Assessing the potential for, and impacts of, sustainable offshore industries.

Ecosystems and Habitats

The deterioration of critical habitat, especially primary nursery areas for recruitment and sustenance of juvenile fish, has been a factor in the decline of many fisheries. A comprehensive, scientific understanding of diverse coastal ecosystem structures and functions is basic to developing strategies for protecting and restoring essential habitat. Degraded water quality also affects the productivity of living resources and jeopardizes the health of coastal ecosystems. State officials seeking to implement the Coastal Habitat Protection Plan need strong scientific data and conclusions.

Priority research and outreach goals include:

- Developing techniques to restore degraded habitats, such as wetlands, streams, riparian buffers, oyster reefs and submerged aquatic vegetation;
- Determining potential economic and biological impacts of beach nourishment, and dredging of inlets and waterways;

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- Developing integrated, multidisciplinary approaches to assess the carrying capacity for coastal natural resources and habitats;
- Developing techniques and approaches for determining the interactive effects of climatic and human perturbations on ecosystem trophic structure and transfer efficiency, and the fate of primary and secondary production in estuarine and coastal waters:
- Developing relevant information for resource managers, regulators and the general public to understand the impacts of habitat alteration and loss on ecosystem function;
- Developing the capability to predict hypoxic/anoxic conditions and determining ecosystem response to these events;
- Determining the feasibility of using various species as indicators of water quality; and
- Determining how sedimentation and turbidity affect estuarine and coastal ocean water quality and how these interactions impact coastal ecosystems and resources.

Fisheries

Fisheries are economically and socially important to the region. North Carolina's commercial and recreational fisheries generate approximately \$3 billion annually. Managers have noted catch declines for some major species, but increases for others. There are growing conflicts regarding allocation of resources to user groups and catch limits. North Carolina is in an era of fisheries planning and management, yet state officials need better information and technology to address the problems. Thus, there is a growing need to develop better management schemes and to improve mechanisms for analysis and decision-making.

Priority research and outreach goals include:

- Developing information about common trends and interactions among and within species for use in comprehensive fisheries management plans and related management data needs;
- Determining the underlying levels of variability or uncertainty in estimates of key fisheries population characteristics, and developing management strategies that acknowledge that uncertainty;

- Identifying and defining critical habitats and the impacts of fishing activities on these habitats;
- Quantifying relationships among climate and oceanic changes, environmental quality and ecological response, and fisheries recruitment and production;
- Identifying and quantifying the effects of harvest, habitat loss, anthropogenic inputs, natural perturbations and water quality on fisheries stocks:
- Developing methodologies to quantify the results of management actions regarding in fish stocks or habitat;
- Determining the ecological and economic impacts of stock enhancement, restoration and/or mitigation projects;
- Introducing new technology to the fishing industry to reduce catch of nontargeted species and increase efficiency of harvest;
- Identifying techniques and gear that reduce mortalities in the growing catch-and-release recreational fisheries, and sharing such information with anglers; and
- Developing information to help people adapt to changes in fishing resources and to identify socioeconomic dimensions in fisheries management decisions.

Marine and Aquatic Science Literacy

With increasing demands on marine and coastal resources, it is imperative that citizens understand the implications surrounding resource use. Informed decisions on coastal management and policy require a continuous flow of research. The results of such research must be translated into science-based information products and educational programs.

Sea Grant's investment in the development of well-prepared coastal scientists, engineers and managers, as well as better-informed citizens, will position the United States to be more competitive in the global economy.

Precollege education includes students and teachers from kindergarten through high school. Marine and coastal education should provide relevant lessons that meet state and federal education standards and also introduce students to professional careers.

Priority education and outreach goals include:

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Coastal Ecosystem & Public Health

National Perspective

Coastal ecosystems are ecologically and economically valuable environments that are subject to multi-use demands, ranging from flood control and the purification of societal wastes to food production, transportation and recreation. These ecosystems support diverse and complex biological communities, providing essential habitat for the fish and shellfish that constitute 75 percent of commercial landings in the United States. Coastal environments also provide essential "ecosystem services" valued in the trillions of dollars annually on a global scale.

Nevertheless, the productivity, diversity and resiliency of these systems have become increasingly threatened by human-induced perturbations. These perturbations cause increased fish kills and the decline of species diversity in benthic communities. Nationally, harmful algal blooms have had an estimated economic impact of nearly \$50 million annually since 1987. Regionally, a massive *Alexandrium* red tide bloom caused commercial failure for the shellfish fishery across the Gulf of Maine

throughout the spring and summer of 2005 at a cost of about \$3 million per week, and some areas remained closed well into 2006. As the U.S. population continues to concentrate along the coast, human-induced impacts on our watersheds, estuaries and near-shore coastal waters increasingly threaten the health and sustainability of these valuable ecosystems.

In June 2003, the Pew Oceans Commission's report, *America's Living Oceans: Charting a Course for Sea Change*, listed point and non-point source pollution, invasive species, coastal development and habitat alteration as major threats to our oceans. The report specifically identified excess nutrient enrichment as the "greatest threat to coastal marine life today."

Similarly, the recommendations of the U.S. Commission on Ocean Policy (2004) and the initial federal response to those recommendations outlined in the *U.S. Ocean Action Plan* highlight coastal ecosystem restoration, prevention of the spread of invasive species, enhancing use of ocean resources by addressing human health issues, pathogen detection, estuarine and coastal ocean observing, and the development of ecological

forecast models for harmful algal blooms and other emerging and nontraditional contaminants as priority areas for research and the application of new and innovative technologies and management tools. These issues are included in the *NOAA Sea Grant Strategic Plan* (2004) and the National Sea Grant Ecosystems and Habitats Theme Team report. The report highlights a specific role for Sea Grant in minimizing the negative impacts of human-induced changes to coastal ecosystems by addressing four areas: reducing stresses on coastal ecosystems, limiting invasive species, assessing and managing coastal watersheds, and conserving and restoring critical habitats.

To effectively address these critical issues and maintain and improve the health of our coastal marine ecosystems, strategies must be found to balance the multiple uses of these environments with the impact of continued growth. Rooted in the development of these new strategies is the need to be able to document and quantify the effects of human perturbations

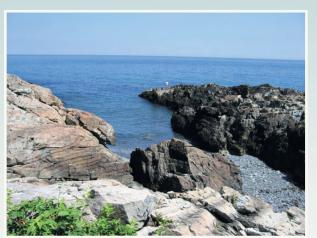
and management practices on these environments. These efforts require new basic research understanding of key organismal and ecological processes, novel technologies, integrated monitoring and modeling methods, development of effective indicators, an ecosystem-based management approach, and the development and implementation of advanced restoration techniques. It is also essential that these scientific efforts be integrated closely with education and outreach efforts to assist states and communities in educating the citizenry of these critical processes.

New Hampshire Perspective

Although New Hampshire is not a particularly populous state (1.3 million residents) and has a relatively short coastline, in many ways it mirrors other coastal states in the pressures of continued population growth and the demographics of that growth. Nearly 75 percent of the state's residents live within 50 miles of the coast, and the rate of growth in the seacoast region has increased 10 percent over the past decade, a rate nearly double that of the rest of the state. Coastal communities, deeply rooted in the resources of their estuaries and coastlines, are struggling with how to manage growth and its associated waste streams. The Great Bay Estuary is displaying indications of nutrient over-enrichment, microbial contamination and habitat loss. Meanwhile coastal fishermen are dealing with harmful algal bloom-related fisheries closures and the cumulative effects of point and non-point source pollution.

The Gulf of Maine and its tributary watersheds and estuaries are critical focal points for our stakeholders. As a result, NH Sea Grant and the University of New Hampshire have played an increasingly central role in regional efforts to understand and effectively manage the Gulf of Maine ecosystem with regional Sea Grant partners, the National Oceanographic and Atmospheric Administration, and a number of federal, state and private partners. Thus, we have a strong desire to continue to support critical

basic and applied research, education and outreach on coastal ecosystem health in our local coastal ecosystems. At the same



time, we believe that we have a unique opportunity to build on our regional partnerships to focus our efforts on developing and enhancing ecosystembased management approaches within our region and in using our local coastal environments as models for other areas of the country.

Strategic Goals and Opportunities

NH Sea Grant has unique capabilities to enhance our understanding of coastal ecosystems and public health. We recognize related ongoing efforts that address the need for improved environmental indicators and the development and application of new technologies, as well as other efforts being conducted by partners in the region. In particular, we foresee close cooperation with the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET) and the UNH Coastal Observing Center. We also recognize the need to address issues related to ecosystem and human health, climate change implications for both, and new issues as they emerge.

Goal 1: Develop and apply biological and chemical indicators to monitor natural and anthropogenic stressors and assess the health of the Gulf of Maine and regional estuaries.

Actions and Opportunities:

X Support research initiatives to develop novel molecular,



- biochemical, organismal and system-level indicators and indices of the health of the Gulf of Maine and regional estuaries.
- **X** Encourage efforts to develop novel approaches to mining existing datasets to assess the ecological health of the Gulf of Maine and regional estuaries.
- **#** Support research efforts to determine the effects of multiple stressors on marine biota and ecosystem processes.
- Here Develop methods to distinguish between anthropogenic impacts to these ecosystems and variability caused by natural processes.
- **#** Improve methods for monitoring and managing the effects of harmful algal blooms.
- **#** Develop early warning systems for the ecosystem impacts of climate change and sea level rise.
- **X** Support the development of new technologies for monitoring, assessing and restoring estuarine and near-coastal environments.
- Advance sensor hardware, data management and interpretive techniques and models to fully integrate the coastal ocean observing system initiative into regional monitoring and management programs and Sea Grant goals.

Goal 2: Identify and model the cumulative effects of population growth and land-use change within the land-sea continuum in regional watersheds on the health of the Gulf of Maine, near-shore areas and regional estuaries.

Actions and Opportunities:

- Identify sources and track the fate of contaminants from specific land-use practices (e.g., nutrients, pathogens, metals and organics) in aquatic marine ecosystems.
- **#** Develop hydrodynamic and GIS-based models to support increased understanding of contaminant sources, fates and impacts.
- Work with local and regional planners, managers and resource users to utilize these data to minimize and reverse the impact of human- and land-based activities on our coastal and estuarine ecosystems.

Goal 3: Characterize status and change within critical estuarine and coastal habitats and keystone organisms in the Gulf of Maine region through assessment of ecosystem processes and conditions.

Actions and Opportunities:

- **Analyze existing long-term datasets to provide critical understanding of the historic and predicted future trends of the properties and processes within critical coastal habitats.
- # Develop cause-and-effect understanding of the physical and biological forces (sea level rise, etc.) affecting these trends.
- **X** Develop predictive models for the future health of critical habitats and keystone organisms.

Goal 4: Provide scientifically based information to support the development of regional ecosystem-based management frameworks and strategies for the Gulf of Maine and regional coastal ecosystems.

Actions and Opportunities:

- **%** Support research and data management to provide a better understanding of physical, biological and chemical processes affecting the Gulf of Maine ecosystem.
- **X** Catalyze and promote the interaction between scientists, socioeconomic experts and managers involved in the development of ecosystem-based management initiatives.
- **#** Identify, examine and fill information gaps critical to the development and implementation of ecosystem-based management models for our regional ecosystems.

Goal 5: Develop and advance approaches for restoration of critical habitats in the Gulf of Maine and regional estuaries.

Actions and Opportunities:

- **X** In partnership with appropriate federal and state agencies, design novel habitat restoration technologies.
- **X** Develop adaptive monitoring strategies and protocols to assess the effectiveness of habitat restoration efforts.

- **X** Develop new techniques to target specific high priority locations for restoration efforts.
- In collaboration with local and state management agencies, develop outreach programs to transfer critical habitat knowledge and restoration technologies to public officials and the citizenry.

Goal 6: Develop and improve methods for the detection, source identification and management of microbial pathogens and harmful algal blooms.

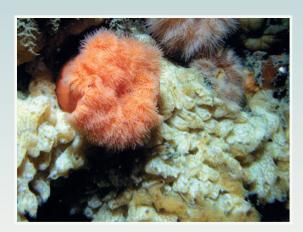
Actions and Opportunities:

- # Develop methods for identifying sources of fecal-borne microbial pathogens in beach and shellfish-growing waters.
- **X** Develop improved and more rapid methods for monitoring water quality.
- Support research on the ecology and dynamics of harmful algal blooms and indigenous microbial pathogens.
- **#** Develop outreach programs to effectively communicate the impact of harmful algal blooms in the region.
- **X** Support the development of new technologies for monitoring, assessing and predicting the effects of pathogens on coastal ecosystems.

Goal 7: Enhance preparedness and reduce loss of human life, property and environmental resources from coastal natural hazards affecting the Gulf of Maine and regional coastal environments.

Actions and Opportunities:

- Work with local and state agencies to provide clear information on the potential impacts of, appropriate planning for, and response to natural disasters, in particular potential hurricane and nor'easter effects.
- **#** Develop outreach programs to effectively communicate the impact of sea level rise in the region.
- **#** Support the development of new models and visualizations for storm-surge impacts.
- **X** Develop outreach programs to effectively communicate the potential impact of storm surge in the region.



Strategic Plan

Research Programs

RESEARCH

National Sea Grant Publishes priority research categories in its Annual Program Guidance, and has developed a National Sea Grant College Program Strategic Plan. The intent of these documents is to provide uniformity within the National Sea Grant Network and to encourage multidisciplinary regional approaches.

economy. To achieve its strategic goals through NJMSC, the New Jersey Sea Grant College Program reaches out to

all relevant federal and state institutions, industry, conservation organizations, coastal stakeholders, and the public

As we embark upon the 21st century, emphasis on global commerce and the shifting priorities in the national economy make the basic precepts of marine research, education and advisory services even more important today

than when NJMSC first introduced the New Jersey Sea Grant College Program to the State of New Jersey. The value of New Jersey Sea Grant has grown steadily by directing attention to the changes, challenges, and opportunities represented by the state's extensive and invaluable marine and coastal resources and sustainable

PUBLICATIONS

RFPs

SEA GRANT FORMS

EXTENSION PROGRAM

Research Priorities at the NJSGCP

SEA GRANT SITE MAP

The research priorities of the New Jersey Sea Grant College Program are both consistent with, and complementary to National Sea Grant College Program's Strategic Plan. Seven relevant areas of research have been identified to meet the long-range needs of New Jersey and the region:

- 1. ecosystem research,
- 2. environmental models,
- 3. coastal zone management,
- 4. marine technology and development,
- 5. biotechnology,
- 6. fisheries and aquaculture, and
- 7. socioeconomic, policy and legal studies.

to achieve consensus on coastal issues of concern.

Ecosystem Research

New Jersey's watersheds and estuaries have been subjected to tremendous development pressures, both industrial and residential. Pollutants in the form of toxic chemicals, pathogens, and nutrients, from a variety of point and non-point sources, have threatened the vitality and quality of local marine ecosystems and marine organisms, and have impaired use of these resources by the public. These pollutants degrade the marine environment and result in adverse health effects, ecological damage, and economic impacts. Consequently, research into watershed dynamics, fate and transport of pollutants, dredged materials management, coastal processes, and coastal ecosystem health remains a priority for the New Jersey Sea Grant College Program. Future Sea Grant ecosystems research will continue to provide useful data for management of the state's estuarine resources in light of the many competing, and often conflicting uses.

Coastal Zone Management

New Jersey's inlets, back bays, passages and thoroughfares, barrier beaches, and other coastal features are environmentally, economically, and culturally important. New Jersey has nearly 200 kilometers (127 miles) of beaches, most on fragile barrier islands. However, relatively few of the state's beaches have been spared indiscriminate, haphazard development, which pose severe problems for coastal managers and barrier beach stability. Coastal hazards caused by hurricanes, northeasters, or other coastal storms annually cause millions of dollars of damage to coastal businesses and communities. In addition, sediment shoaling of inlets, back bays, and other coastal waterways interferes with coastal navigation. New Jersey Sea Grant will focus its activities in this discipline on developing science-based analysis tools for coastal managers based on improved monitoring and modeling of coastal processes, and understanding coastal ecosystems behavior as a consequence of system dynamics and human intervention.

Environmental Models

The complex nature of marine ecosystems requires a research approach that extends beyond traditional, descriptive studies of local ecosystems. Investigations must focus on fundamental ecological processes that regulate ecosystem structure and function, and the response of ecosystems to natural variability and anthropogenic change. Appropriate management decisions related to coastal resources and coastal zone issues not only require quantitative understanding of the processes involved but also demand accurate models for predicting the impacts of natural and man-made changes.

Marine Technology Research and Development

The New Jersey Sea Grant College Program will invest in state-of-the-art marine technology and engineering

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research that addresses coastal issues especially in the area of beach erosion control and coastal hazard mitigation. This focus on marine technology and engineering is partially fostered by the special competence and facilities offered by a number of member institutions.

Biotechnology

New Jersey is home to more than 175 companies that actively engage in research and development in the biotechnology field. Many of the products generated by these firms are household names and are constantly being improved as new technology emerges. New Jersey Sea Grant has engaged its research community in seeking new pharmaceutical and other bioactive products from living marine sources; developing new bioremediation methodologies to eliminate toxic and other chemical pollutants in the marine environment; improving living resource productivity and crop yields by introduction of new technologies in aquaculture; improving identification of different species of marine organisms through new methods of biotechnology including molecular probes; and developing new biotechnological approaches to enhance the quality, disease resistance and survivability of living marine resources.

Fisheries and Aquaculture

New Jersey's fishery resources contribute more than \$2 billion annually to the state's economy. Commercial fisheries in New Jersey rank among the most productive on the East Coast and in the nation. In addition, New Jersey recreational fisheries are among the nation's leaders in terms of angler expenditures, revenue generated, and angler participation The New Jersey Sea Grant College Program conducts extensive fisheries research to assist managers in the development and conservation of commercial and recreational species.

The demand for fish and seafood products in the United States has risen recently as a result of increasing public awareness of the nutritional and health benefits of eating seafood. This demand comes at a time when many traditional fishery resources are being harvested at, or near, sustainable yields. As a result, aquaculture has emerged as a growing US industry that supplements wild fisheries. Although some species are economically feasible to culture in New Jersey, much work remains to facilitate development of commercial-scale ventures. New Jersey Sea Grant will continue to invest resources in promoting the potential for aquaculture enterprises in New Jersey by raising awareness of aquaculture opportunities; helping to reduce impediments to initiate environmentally sound aquaculture businesses; developing proactive programs to manage aquatic organism health and mortality in culture systems; improving the quality of and efficiency of natural and artificial feeds; and improving the profitability of current aquaculture systems.

Socioeconomic, Policy and Legal Studies

Recognition of humans in the landscape, and the need to integrate the social sciences into sustainability approaches to coastal zone management is at the core of modern sustainability science. In order to provide relevant information for the wise use of New Jersey's coastal and marine resources, New Jersey Sea Grant is interested in studies that involve collection and analysis of appropriate socioeconomic and policy-related data and information, analysis of social change, analysis of natural resource management options, suggestions for alternative institutional arrangements, socioeconomic impact studies, and identification of legal and policy constraints to the development of coastal businesses.

NEW JERSEY SEA GRANT COLLEGE PROGRAM STRATEGIC GOALS, 2004-2008

New Jersey Sea Grant College Program activities involve more than 50 percent of its member institutions currently focusing in the areas of:



Coastal ecosystem health including atmospheric deposition, fate and transport of toxic compounds, harmful algal blooms, dredged materials management; homeland security and preparedness; innovative products from the sea. shellfish disease: habitat restoration: essential fish habitat and aquaculture technology:



Technology transfer of ecosystem and marine technology research to product development, resource management, or policy-formulation; and



Heightening public awareness of key coastal issues through multimedia tools and pre-college education.

Strategic Goal 1



Match the national science agenda with New Jersey's local knowledge, skills and priorities; and



the public knowledge through a wide-range of marine-related basic and applied research in New Jersey and the mid-Atlantic region.

Strategic Goal 1

Identify relevant New Jersey coastal issues through a collective stakeholder process, and seek a balanced and objective response to addressing consensus issues through research, education and outreach

Sea Grant Advisory Board (SGAB)

To strengthen ties between the research and user communities, the New Jersey Sea Grant College Program convenes a Sea Grant Advisory Board (SGAB). The primary responsibility of the Board is to provide advice to

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management and staff in all matters related to coastal issues and the *New Jersey Sea Grant College Program*. This advice encompasses a local perspective on coastal issues, program review and policy development by:

Commenting on the focus, orientation and progress of the New Jersey Sea Grant College Program in context of changing needs and priorities, program balance, initiatives and new directions;

Reviewing pre-proposals and full proposals;

Holding discussions with the *New Jersey Sea Grant College Program* Director from the perspective of user groups in each major program area;

Assisting the New Jersey Sea Grant College Program office in identifying and encouraging participation of appropriate talent in the program;

Providing comments to the New Jersey Sea Grant College Program applicable to solving problems considered critical to New Jersey's marine-related economy and more broadly, to regional and national needs.

SGAB membership is drawn from a balanced cross-section of New Jersey's user community — marine industries, private citizens, advocacy groups, utilities, and federal, state and local governmental agencies representing: Aquaculture, Biotechnology, Coastal zone management, commercial fishing, environmental advocacy, marine trades, maritime industry, petrochemical industry, pharmaceutical industry, policy and planning commissions, private citizens, recreational fishing, regulatory/resource agencies, and shore tourism,

Scientific Advisory Committee (SAC)

The Scientific Advisory Committee consists of experienced senior scientists from the region, but outside of New Jersey, with expertise in the following: aquatic ecology, biogeochemical cycling, biotechnology, coastal ecology, dredged materials management, ecological engineering, education, environmental chemistry, environmental modeling, fish and shellfish aquaculture, fisheries science and management, shore process and coastal engineering and social, policy and economic sciences

The SAC provides technical advice and ranking of proposals (or pre-proposals). Working interactively, the SAC and SGAB recommend a "slate" of relevant and technically meritorious proposals to the Sea Grant Director for potential funding.

Strategic Goal 2



Integrate ecological with socio-economic studies to address issues associated with the "coastal commons"— fisheries management, public access, ports, sustainable coastal communities and aquaculture;

Strategic Goal 2

Develop a coastal research agenda that addresses ecological, social, cultural, and economic issues built on the needs of marine industries, government, resource managers and the public; focus relevant research on stakeholder generated issues whose outcomes and products reach the broadest possible number of New Jersey and regional constituents

Promote regional approaches to improved management of limited coastal resources;

Contribute to the development of ecosystem-based approaches to fisheries management;

Focus landscape level research on essential habitat and "bottom-up" management of fisheries vis-à-vis better understanding between habitat and early life history stages.

Meld the science and practice of restoration ecology and habitat restoration;

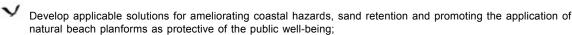
Promote marine biotechnology as a source of useful products from the sea;

Employ genetic engineering and other biotechnology techniques to address oyster diseases, improved culture of hard clams and finfish;

Develop sustainable, economically feasible, and environmentally "friendly" aquaculture production for existing, new or alternative species;

Address source control, fate and transport of toxic compounds in the New Jersey-New York Harbor and Delaware Bay; develop cost-effective and environmentally benign methods for stabilization and beneficial uses of dredged materials, contribute to understanding the underlying basis for harmful algal blooms;

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Improve the understanding of regional coastal sediment transport and shoreline stability factors including bayshore processes;

Incorporate existing and future coastal ocean data streams in improved coastal models, forecasting and analysis;

Understand the underlying processes of bay shoreline evolution; and

Contribute natural and bioengineering solutions to the stabilization and restoration of bay shorelines.

Strategic Goal 3

Coastal issues in New Jersey are no less prominent than in other Sea Grant states and, in an austere economic environment, alternatives are constantly sought to supplement limited federal funds with local partnerships. In addition to expanding the overall pool of dollars, partnerships enhance the probability that sufficient funds will be available to support large-scale multidisciplinary projects. In recent years, the New Jersey Sea Grant College program has increased its core funding by more than 40% in local and regional partnerships.

Strategic Goal 3

Expand the <u>New Jersey Sea Grant College Program</u> capabilities through local and regional academic, private sector, municipal, and government partnerships

Habitat Initiative

A unique collaboration has developed among the *New Jersey Sea Grant College Program*, other regional Sea Grant institutions, state and federal agencies and the private sector to co-fund basic and applied research in coastal habitats. With an investment of approximately \$700,000 Sea Grant dollars over the past five years, the NJSGCP has secured grants, contracts, co-sponsorship and donations to build a \$4.2 million Habitat Initiative in the region and nationally. Originally focused on one of the largest wetland projects of its kind in the world, the restoration of more than 4,050 hectares.

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Objective d. Assist marine and Great Lakes coastal landowners, public decision-makers, and contractors to deal with high or low water, flooding, and/or erosion events.

Objective e. Provide technical assistance and advice to local, state and federal partners in the development of large-scale and regional coastal hazard evaluation, prevention or mitigation programs and projects.

Objective f. Develop forecasting, planning and legal strategies to deal with Great Lakes Basin water withdrawals to equip communities to assess the impacts and make decisions about tradeoffs among water rights, domestic and international fresh water export, and commercialization or privatization of water treatment and supply and water uses within the basin, e.g., to prevent erosion, for navigation, boating, fishing, energy generation, etc.

Goal 3: New Yorkers will be able to understand, evaluate, reduce and mitigate anthropogenic impacts on, and restore structure and function of, coastal ecosystems and habitats.

Rationale - Development of the marine, Hudson River and Great Lakes coasts has put tremendous pressure on wetlands and other coastal habitats and, as a result, on coastal biological resources. It is important to gain a scientific understanding of the processes involved in habitat degradation and to educate coastal decision makers, particularly in estuarine areas such as the Peconics, NY Harbor and the Long Island Sound, about how such processes can be influenced by restoration activities to support sustainable coastal development.

Objective a. Use small grants programs, endowments and public involvement to provide support for coastal habitat restoration.

Objective b. Develop, refine or extend techniques and indicators to examine the effect of human activities on coastal habitat quality, to determine if habitats have been degraded or fragmented, to estimate human carrying capacity in coastal areas and to manage human access to these habitats.

Objective c. Develop and extend techniques to determine the ecological processes and functions of coastal or underwater areas and ecosystems as well as how they may link to their watersheds.

Objective d. Evaluate the costs, benefits, and effectiveness of implemented, proposed, and developing techniques (including marine protected areas) to protect or restore coastal and underwater habitats and ecosystems and extend the results.

Objective e. Develop methods to predict whether or what habitat or ecosystem effects may result from new coastal structures (e.g., wind farms, gas terminals,

replacement of aging infrastructure), different management strategies (e.g., for mosquito control), and other changes (e.g., in water level, modernized transportation).

Objective f. Participate and involve professionals (agencies, academics) in educating the public about the contributions and value of coastal habitats to the structure and function of ecosystems, ways to sustainably use coastal habitats, and the benefits and costs of habitat restoration with particular reference to specific threatened, degraded or compromised habitats and/or Great Lakes Areas of Concern.

Goal 4: New York's resource managers and fishers will work together to sustainably use, protect, maintain and restore New York's recreational and commercial fisheries.

Rationale - Fisheries in the Great Lakes (smallmouth bass, various salmon spp.), Hudson River (sturgeon, striped bass) and marine district (shellfish, bluefish, porgy) provide the basis for recreational or commercial industries that contribute over \$3.7 billion per year to the NYS economy. However, each of these fisheries is threatened, putting these economic contributions at risk. By understanding the controls on these fisheries and how to restore them, as well as educating resource managers and users to participate together in developing innovative management approaches (e.g., ecosystem-based management strategies), NYSG can provide a critical service to the state.

Objective a. Develop new or use existing stock assessment and other tools to evaluate and potentially mitigate the effects of historical, recent, current and future stressors (including environmental changes, pathogens, pollutants, other biota, the fishery itself and mitigation techniques, as well as their combined effects) on recreational and commercial fisheries and transfer the information to decision-makers.

Objective b: Identify and evaluate techniques that will maintain or restore fisheries health by reducing inadvertent mortality and sublethal effects of fishing. Identify new harvesting techniques to diminish impediments to economic and ecological sustainability in fisheries. Develop techniques to inform fisheries stakeholders about the proper use of these techniques.

Objective c: Develop techniques to identify sustainable effort and determine how management practices/strategies affect fisheries sustainability, especially in the face of ecosystem changes. Engage and empower stakeholders in decision-making processes by helping them use these expanded abilities to forecast the impacts of management actions.

Objective d: Improve capabilities to predict socioeconomic responses of coastal communities to changes in fisheries resources or accessibility, and develop

economic information to assist these communities to make more informed decisions.

Objective e. Develop models that link abiotic and biotic ecosystem processes to fish or shellfish abundance, biomass, recruitment, production, and harvest, and educate fisheries managers and stakeholders on their value in fisheries management.

Objective f. Develop and/or evaluate the feasibility and efficacy of techniques for the identification, maintenance, restoration, and enhancement of critical habitat for important aquatic species

Goal 5: New Yorker's will reduce the spread of Aquatic Invasive Species (AIS) and predict and minimize the ecological and economic impacts of AIS and Aquatic Nuisance Species (ANS)

Rationale - Invasive species (IS) are costing municipal drinking water treatment and industrial plants (e.g., electric power plants) in the State millions of dollars each year in control or cleanup costs. IS are also affecting aquatic ecosystem structure and function, in some cases incurring economic losses via effects on recreational fishery-related tourism, etc. Understanding the biotic, abiotic, and anthropogenic processes and conditions that influence introduction, population dynamics and distributions of AIS and ANS, and fostering communication among scientists and industries will speed development of effective prevention and control measures and prevent wasteful application of ineffective strategies or policies.

Objective a. Determine the biotic, abiotic, and anthropogenic processes and conditions that influence introduction, population dynamics and distributions of AIS and ANS, including animals, plants, harmful algal blooms, diseases, and parasites, in order to develop strategies for prevention or mitigation. Extend these results to stakeholders.

Objective b. Determine the environmental, ecological, economic, and synergistic impacts and effects of AIS and ANS, and their causal mechanisms and develop effective response, detection, and control mechanisms.

Objective c. Educate the general public, other stakeholders, and the next generation of stakeholders (K-12) throughout North America about prediction, prevention, introduction and distribution vectors, management, control, impact and mitigation of AIS and ANS via traditional outreach methods, as well as operation of the National Aquatic Nuisance Species Clearinghouse and World Wide Web searchable database and Northeast water chestnut outreach website.

Objective d. Improve our understanding of the biology of AIS and ANS especially as it relates to monitoring for prevention of introduction and spread, response to potential control methods, and predicting and assessing potential threats to and impacts on infrastructure, ecosystems and human health.

Objective e. Develop risk assessment techniques to predict future AIS introductions and ANS and AIS proliferation and methods to enhance early detection, response, control and mitigation.

Goal 6: Coastal resource development and protection will be supported by a new generation of motivated, highly educated scientists and environmentally aware and informed decision-makers and citizens.

Rationale - Knowledge is a necessary component of sustainable coastal resource decision-making. Coastal scientists generate the understanding of the interaction of anthropogenic activities and the environment that informs wise decision-making. An informed public, be they environmental activists, agency employees or the general citizenry, can support politicians that make astute, effective and efficient choices among alternative resource decisions. Life cycle education in both formal and informal venues fosters an informed public.

Objective a. Work with Marine and Great Lakes educators to integrate new technologies and Sea Grant resources into experiential teacher training, K-12 classrooms and informal teaching venues.

Objective b. Prepare the next generation of coastal science professionals and decision-makers by supporting Sea Grant Scholars and by providing coastal information to New York's college and university students.

Objective c. Partner with nature centers, museums, aquaria and other environmental entities to provide science-based, non-formal education on Sea Grant issues and techniques to groups such as scouts, 4-H clubs, etc.

Objective d. Develop and distribute educational materials relevant to coastal issues to Congress, state legislators, and stakeholders in an effort to aid these groups in making predictions and decisions.

Objective e. Develop and use new communications techniques and strategies to foster an educated citizenry by reaching out to stakeholders and the general public.

Objective f. Utilizing educational programs and materials, provide information to local school, youth and environmental groups to support their conservation and restoration efforts toward coastal stewardship.

Goal 7: NYS seafood processors will effectively and profitably market safe, high quality seafood products to knowledgeable consumers.

VI. Ecosystems and Habitats

A. Understand the impact of and reduce stresses on coastal systems

Goal: Support research to improve our ability to understand and forecast ecosystem changes in Lake Erie caused by stresses to the system and reduce the impact of these stresses with particular emphasis on fisheries, harmful algal blooms, nutrient and contaminant loading, sewage outflows, and the Central Basin Dead Zone.

Objective: Unravel the Lake Erie food web and the trophic pathways of nutrients and contaminants in the system.

Objective: Develop and disseminate new technologies that are safe and capable of detecting, removing, and/or detoxifying contaminants in a cost-effective manner.

Objective: Develop and evaluate new technologies to remove and/or detoxify contaminants in Areas of Concern.

Objective: Support and participate in regional efforts through the Great Lakes Commission, USEPA, and the Council of Great Lakes Governors to bring about restoration and recovery of the Great Lakes ecosystem.



B. Coastal watersheds

Goal: Develop integrated watershed approaches that engage researchers and coastal communities to pursue the common goal of managing watersheds in a sustainable fashion by developing the science-based information needed to predict changes in coastal ecosystems and habitats arising from changes in land and water use in watersheds.

Objective: Develop the necessary scientific information to manage Lake Erie as an ecosystem.

Objective: Quantify the impacts of human activities on the aquatic environment and transfer the information to managers to influence the decision-making process at the local community and watershed levels.

C. Conserving and restoring coastal habitats

Goal: Empower coastal communities to undertake well-planned coastal development that preserves, restores, and/or enhances coastal habitats by promoting wetland banking, rehabilitation of brownfields, stabilization and restoration of beaches, and establishment of protected areas.



Objective: Extend the results of artificial reef research to decision makers considering reef or near-shore construction.

Objective: Evaluate natural processes and alternative rejuvenation strategies (including wetland mitigation and biotechnology) to improve damaged ecosystems.

Objective: Develop and implement Special Area Management Plans for coastal regions in collaboration with the Ohio Coastal Management Program.

Objective: Support research and outreach efforts on the role and value of wetlands as critical wildlife habitat and in nutrient/contaminant removal and assist managers in developing appropriate strategies to mitigate wetland loss.

Theme Area V. The Digital Ocean

This theme area has elements in several of the other areas, but we particularly want to highlight our interest in digital imagery and education.

Goal V.A. To develop effective tools and approaches to using digital imagery to assist decision makers and to enhance public education.

Theme Area VI. Ecosystems and Habitats

Since 1998 our interest in coastal ecosystems largely has revolved around essential fish habitat, ecosystem restoration, and aquatic nuisance species. Although considerable progress has been made, those issues continue to be important, and they remain among our highest priorities. We plan to maintain outreach efforts in the areas of watershed restoration and aquatic nuisance species. On the other hand, our research goals and objectives in this theme area will be somewhat more focused, with a special emphasis on estuaries and estuarine restoration. We recognize that several million dollars are invested annually by various agencies on research relating to Pacific Northwest watersheds and that a similar though smaller investment is made in studies of estuaries. For that reason, we will place our emphasis on forming partnerships and on supporting research on key topics that would otherwise be missed.

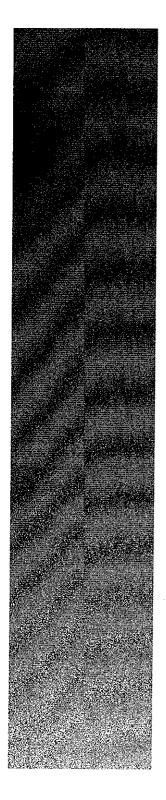
Goal VI. A. To enhance public understanding of issues surrounding aquatic nuisance species and particularly of the role that citizens can play in preventing the introduction of such species.

Goal VI. B. To educate decision makers and the public about the importance of coastal watersheds and about effective approaches to their restoration.

Theme Area VII. Fisheries

The work we seek to support in this theme area will integrate research and outreach and will make use of partnerships with industry, agencies, and others to address major problems. Our programmatic emphasis will be on research and outreach that addresses the many unknowns and uncertainties in our understanding of the life histories and habitat needs of groundfish and salmonids. Our priorities also include research on innovative approaches to fishery management and on outreach that improves communications among fishery stakeholders and that assists the fishing community.

Goal VII.A. To improve the models on which management is based.



Goal VII.B. To improve communications and decrease fragmentation within the fishing community, particularly between gear types, and to support the fishing community through this period of economic and social upheaval.

Goal VII.C. To improve communications and understanding among coastal communities, the recreational and commercial fishing industries, and academic and agency scientists.

Goal VII.D. To identify innovative and effective approaches to fishery management and assist industry leaders and managers in understanding the benefits and limitations of such approaches.

Theme Area VIII. Marine and Aquatic Science Literacy

Enhancing marine and aquatic science literacy through varied programs of marine education is one of Oregon Sea Grant's highest priority thematic goals. In fact, each of the marine and coastal issues that this program addresses has the potential to be the focus of programs to improve science literacy in various audiences. In that sense, science literacy is a component of all of our other high-priority programmatic themes, and it is therefore listed below among the crosscutting themes. In addition, Oregon Sea Grant plans to conduct and support activities that specifically target this important theme area and that contribute specifically to the art and science of marine education.

The Visitor Center of the OSU Hatfield Marine Science Center includes exhibits, aquaria, and other displays that are seen by about 150,000 visitors annually. The youth marine education program annually serves nearly 12,000 K–12 students from all over the Northwest, including Montana and northern California. Oregon Sea Grant is responsible for operating and managing the center, which allows us to use the center as a kind of teaching and research laboratory in which to carry out studies that will improve the art and science of lifelong learning.

Goal VIII.A. To create a more scientifically and environmentally informed citizenry.

Goal VIII.B. To develop and test strategies and tools for effective informal science education.

Goal VIII.C. To improve the science education competencies of professionals in lifelong learning.

Goal VIII.D. To enhance the training of teachers in marine sciences and to develop educational materials for teachers and students.

GOALS AND OBJECTIVES

PROGRAM AREA ONE: EXTENSION

Goal: To facilitate a balanced public understanding of environmental resources and issues impacting Pennsylvania's coastal communities and ecosystems.

Sub-Area A: Ecosystem Stewardship

Objective 1: Foster effective aquatic invasive species (AIS) prevention and control in Pennsylvania.

Action Items:

- Participate in the Pennsylvania Invasive Species Council's efforts to advance and formulate effective management strategies leading to the development of a comprehensive statewide AIS policy.
- Coordinate AIS Hazard Analysis Critical Control Point Analysis (HACCP) training with the Great Lakes and Mid-Atlantic Sea Grant Networks.
- Participate on the Great Lakes AIS Panel and Mid-Atlantic AIS Panel.
- Participate on the National Sea Grant AIS Theme Team and assist in the development of associated outreach materials.
- Develop outreach programs which address priority AIS such as flathead catfish, round goby, Asian carp, northern snakehead, rusty crayfish, and water chestnut.
- Promote applied research which addresses critical AIS issues.
- Promote outreach and research to prevent and control the spread of AIS to inland waters.
- Serve as a member of the Great Lake's Network Habitattitude campaign.

Objective 2: Take a lead role in identifying and addressing Great Lakes and Mid-Atlantic coastal environmental issues.

Action Items:

- Expand understanding of disease pathways for avian botulism.
- Take a lead role in the development of assessment standards for fish tumors and other deformities associated with Great Lakes areas of concern (AOC).
- Facilitate the development and implementation of a sediment monitoring plan and delisting criteria for the Presque Isle Bay AOC.
- Participate in the Schuylkill Action Network nutrient remediation effort.
- Initiate outreach related to an increased understanding of atmospheric deposition impacts on aquatic ecosystems.

Objective 3: Promote the sustainability of Pennsylvania's fisheries and associated species.

Action Items:

• Maintain the Pennsylvania Sea Grant *Trichoptera*, *Dipera*, and *Plecoptera* database developed by Ed Masteller for Pennsylvania.

- Develop a statewide aquaculture research and outreach program in conjunction with Penn State University, University of Pennsylvania, and the U.S. Fish and Wildlife Service Northeast Fishery Center's Fish Technology Center in Lamar, Pennsylvania, and others.
- Support research and outreach that sustains the biodiversity in Pennsylvania waters.

Sub-Area B. Coastal Safety and Human Health

Objective 1: Improve safety, environmental quality, and human health related to coastal recreation.

Action Items:

- Support the work of the Pennsylvania Fish and Boat Commission and other organizations to promote boater safety.
- Fully develop the Fleet Surgeon program as a resource for coastal medical and safety issues.
- Work with Pennsylvania's Coastal Zone Management (CZM) Program to coordinate the development of Clean Marina and Smart Boating programs in Pennsylvania to prevent pollution and improve water quality.
- Collaborate with related organizations to address human health issues such as microbial contamination, West Nile virus, and botulism.

Objective 2: Promote seafood and wildlife consumption safety.

Action Items:

- Coordinate the development of easy-to-understand fish consumption advisories with state and local agencies, including multilingual versions.
- Continue research and outreach related to recreational fish consumption issues.
- Initiate and support seafood safety workshops.
- Develop awareness of other wildlife consumption advisories such as snapping turtles and waterfowl.
- Promote HACCP approach to seafood safety.
- Expand understanding of contaminant biomagnification issues.

Sub-Area C. Coastal Communities

Objective 1: Promote Smart Growth initiatives.

Action Items:

- Encourage efforts to revitalize older urban areas and conserve rural resource areas.
- Support farmland preservation efforts.
- Take a leadership role in the identification and preservation of biodiverse areas.
- Assist municipalities with grant applications to address open space and other land preservation efforts.

Key Thematic Areas

representatives from: the University of the Virgin Islands, Environmental NGOs, the Department of Marine Sciences (UPR-Mayagüez), the Department of Marine Biology (UPR-Humacao), the Center for Applied Social Research (UPR-Mayagüez), the School of Natural Sciences (UPR-Río Piedras), a representative of the government, and a member of the program's clientele.

C. Key thematic areas

Our program faces unique challenges due to the multicultural, insular and tropical environment in which it is located. The following are key thematic areas and issues to which our program will devote effort and resources over the next decade.

C. | Water quality

Challenges

- Improve water quality in coastal and marine environments.
- Promote the development of beach protection and conservation-related legislation.
- ◆ Coordinate the establishment of volunteer monitoring groups to test water quality.
- ◆ Contribute to the development and implementation of Puerto Rico's and the U.S. Virgin Islands' non-point source pollution control plan.
- Incorporate communities and stakeholders in the identification and solution of local environmental problems related to water quality.
- Review existing water quality standards and undertake the scientific research to develop tropical water quality standards.

Actions

- Establish water quality as a research priority in our program.
- Develop research projects with MOP staff in this specialization.
- Collaborate with governmental agencies in beach-related and water quality projects.





Key Thematic Areas





- Assist government regulatory agencies to establish guidelines for allowable water quality tolerances through applied research and monitoring.
- ◆ Advise the public and private sectors on strategies for implementing non-point source pollution control practices.
- Promote, assist and educate communities and nongovernmental organizations in environmental problemsolving.

C.2 Fisheries and Mariculture

Challenges

- Reduce the trend in diminishing stocks and effects of overfishing.
- Increase the identification, mapping, and conservation of Essential Fish Habitats.
- Explore innovative fishery management techniques.
- Promote mariculture ventures of ornamental reef fish and other organisms, in order to provide economic opportunities for Puerto Rico and other Caribbean islands, while reducing the extraction of these organisms from their natural environment.
- Establish the UPRSGCP as a regional leader in the development of mariculture initiatives that will offer a seafood and economic alternative in Puerto Rico and the U.S. Virgin Islands.
- Establish mariculture as a long-term research and outreach programatic area.
- Reduce health risks due to the mishandling of seafood, through HACCP training.
- Increase awareness of fishers and stakeholders on fisheries legislation, sustainable fishery practices, habitat loss and fishery management options including the function and value of Marine Protected Areas.



Key Thematic Areas





Actions

- Assess the effectiveness of Marine Protected Areas as a management option for protecting both the fisheries and essential fish habitats.
- ◆ Actively educate fishers and stakeholders on fishery legislation, catch reporting and management plans.
- Promote and support coastal, marine shelf and benthic habitat mapping and Essential Fish Habitat identification.
- Develop education and public policy strategies to reduce coastal habitat degradation sources.
- Develop efforts in habitat restoration.
- Increase public awareness of the critical problem of habitat loss.
- Promote coral reef monitoring programs.
- Establish mariculture as a research and outreach priority in our program, and promote mariculture as a significant source of quality seafood in the Caribbean basin.
- Educate the general public about mariculture and maricultured products; promote the nutritional benefits associated with the consumption of maricultured products, and the economic benefits associated with the development of the mariculture industry.
- Provide interested constituents with information related to the establishment of mariculture projects (laws and regulations, permits, targeted species, technical advisory services, loans, source of seeds, grants, and financial and business opportunities).
- Stimulate the local government to address stricter seafood regulations, inspection and reporting of illness caused by seafood consumption.
- Improve the overall quality and safety of the seafood products marketed in Puerto Rico.
- Expand the capabilities of our Caribbean colleagues to attain seafood quality and safety.





Sustainable Coastal Communities and Ecosystems

America's Coastal Challenges

In 1800, a mere 2 percent of the human population lived in urban environments. In 1900, no city exceeded 10 million residents. By 2000, 19 cities exceeded 10 million, with the Mexico City metropolitan region being the largest at approximately 17 million. By 2010, most of the world's people will live in cities. But these cities will bear little resemblance to those considered large 50 years ago.

The United States is the only advanced industrialized country continuing to experience rapid human population growth. Most of this growth stems from immigration. The United States takes in about 1.1 million of the world's two million migrants annually, more than five times the next largest recipient nation, Germany.

Where is population growth concentrated in the United States? Coastal cities or megalopolises. U.S. coastal counties encompass a small fraction of the nation's land, but they are home to over half the U.S. population. Between today and 2015, the U.S. coastal resident population is expected to increase by 27 percent to 25 million people. In addition, more than 180 million people visit or seasonally reside along the nation's coasts annually. It is estimated that of all U.S. land that has been converted from rural to urban area since European settlement, one quarter has been converted during the last 15 years (an area the size of Ohio). If this urbanization trend continues, 68 million acres of additional land will be developed in the United States by 2025 (Beach, 2002).

Urban sprawl increases the extent of the built environment, including industrial facilities, commercial buildings, residential houses, parking lots, and roads. By 2025, more than 25 percent of U.S. coastal watersheds will be covered by impervious surfaces—60 percent in the mid-Atlantic region. Studies indicate that ecosystem health is seriously impaired when the impervious area in a watershed reaches 10 percent. If current coastal growth trends continue, many healthy coastal watersheds will cross the 10 percent threshold over the next 25 years.

As coastal communities expand, so does their vulnerability to coastal hazards—winds, waves, and floods generated by hurricanes and other major storms—and to geophysical hazards such as land subsidence and shoreline erosion. Excessive nutrient inputs and other forms of pollution will increasingly exert toxicological effects and alter ecosystems. The impacts of these climatic, geological, and pollution hazards will be compounded by projected rises in sea level due to global climate change. Even in absence of such combined effects, the social and economic consequences of these events have been dramatically increased by coastal population growth and urbanization, as exemplified by the hurricanes that ravaged Florida and the U.S. Gulf Coast in 2004.

The cumulative environmental consequences of coastal development are insidious:

- More than 20,000 acres of vital coastal habitat are significantly altered each year
- Sixty percent of U.S. coastal rivers and estuaries suffer major impacts from nutrient discharges and runoff
- Wastewater effluent discharges exceeding 2.3 trillion gallons enter U.S. coastal waters daily

 Oil discharges equivalent in volume to the 1990 Exxon Valdez spill enter U.S. coastal waters every eight months

Finally, the unsustainable use of energy, water, and materials in our coastal communities contributes to the degradation of coastal habitats and contamination of our air and water. Polluted waters impact water-based businesses and recreational activities, with attendant economic costs. Largely unrecognized is the fact that the physical design of our buildings and communities greatly affects the health of habitats and ecosystems. Currently, the built environment in coastal areas is remarkably inefficient in its use of energy and water—two precious natural resources—and in its handling of waste materials. Addressing the numerous impacts of paved coastal watersheds, unsustainable consumption of our natural resources, and waste assimilation practices is just part of the daunting challenge the United States faces in managing coastal urbanization to ensure long-term sustainability of coastal communities and ecosystems.

Rhode Island: The Ocean State

There is much in Rhode Island and its surrounding marine waters to celebrate and protect. Rhode Island offers exceptional historical and cultural attractions, unparalleled boating and fishing, superb swimming, and scenic vistas. From the early 1600s to the present day, Narragansett Bay, the south shore's coastal beaches and lagoons, and Rhode Island and Block Island sounds have shaped Rhode Island's identity and economy. The state's 425-mile coastline offers ocean beaches, coastal lagoons, tidal rivers, pristine salt marshes and tidal flats, miles of rocky shoreline, and historic urban waterfronts. These habitats support a wide variety of fish and wildlife, contribute greatly to the state's biological integrity and diversity, and help support the state's economy: \$75 million in commercial fishery landings, a recreational fishery valued at \$150 million, and a tourism and recreation industry valued at \$2 billion on Narragansett Bay alone. The Ocean State has the largest water area to total area of any New England state. It is also the second most densely populated state in the United States, with about 1,000 people per square mile.

Significant components of Rhode Island's economy depend upon the quality and productivity of the state's marine and coastal resources. Rhode Island hosts a robust, globally competitive marine economic cluster consisting of the following industries and institutions (Rhode Island Senate Policy Office, 2004):

- Marine transportation
- Research and ocean technology development
- Military
- Fisheries and aquaculture
- Boatbuilding
- Boat-related (marinas and other boating support services)
- Tourism, recreation, and events
- Shipbuilding

Narragansett Bay is one of the best known recreational boating areas in the world, particularly for sailing. During the summer, major yachting events cater to national and international clientele, generating millions of tourism dollars for Rhode Island. In addition, in the year 2000, some 300,000 saltwater anglers made one million fishing trips, with the majority of the anglers coming from out of state (Lazar and Lake, 2001).

Rhode Island's Coastal Challenges

Many of the U.S. coastal development trends are mirrored in Rhode Island. Rhode Island grapples with the challenges of intensifying marine and coastal uses and continued residential and commercial development. Essentially a city-state located in southern New England at the northern end of the Washington–Boston megalopolis, Rhode Island continues to experience significant development pressures as well as numerous other coastal environmental management challenges.

As in other U.S. coastal regions, sprawl development, nonpoint source pollution, habitat degradation and destruction, invasive species, climate change, harmful algal blooms, shoreline development, and armoring continue to threaten the quality of Rhode Island's coastal habitats, waters, and resources. Between 1990 and 2000, Rhode Island experienced very little net gain in population, yet 25,000 additional acres of land were developed for suburban homes, retail shopping districts, and industrial parks. The drought of 2002 revealed the many wasteful and ultimately unsustainable drinking-water consumption practices associated primarily with suburban communities but also with agriculture.

Rhode Island Sea Grant's Strategic Responses

Rhode Islanders are currently investing \$318 million in collecting and treating storm water in the Providence metropolitan region via the Narragansett Bay Commission's Combined Sewer Overflow (CSO) Abatement Project. Until completion of this project by 2008, much of upper Narragansett Bay will remain closed to commercial and recreational shellfishing, and Bay beaches will remain vulnerable to public health closures following major rainfall events due to CSO and stormwater discharges.

Recent Rhode Island Sea Grant-funded research has demonstrated how nutrient loading and long-term warming of nearshore marine waters by global warming may contribute to the continued loss of eelgrass beds, to poor-to-nonexistent recovery of local winter flounder stocks, to reductions in estuarine ecological community structure and diversity, and may lead to the proliferation of lobster shell disease in regional stocks.

In addition to major investments in wastewater treatment infrastructure, in 2004. Rhode Island began a new era of marine planning with the passage of several planning and management reform acts by the state legislature. This new legislation reflects heightened concerns regarding the health and resource productivity of Narragansett Bay, Rhode Island's south shore coastal lagoons, and territorial seas. Continued shoreline development has also increased user conflicts such as marina expansions. Many Rhode Islanders and their government leaders now recognize that superb quality of life is one of Rhode Island's most important assets for attracting service economy businesses.

The elements of public concern and scientific and technical insight necessary to launch a new era of integrated marine environmental management have been evolving steadily over the last 25 years (Rhode Island Senate, 2004). As with the rest of New England, Rhode Island endured a tumultuous transformation from a manufacturing economy with center-city dominance to a service economy with a more distributed population. Environmental and natural resource planning and management have become core state and municipal governmental functions. Median incomes decreased 4 percent in Rhode Island from 1989 to 2003, while median incomes across New England grew over the same time period. Since the early 1970s, Rhode Island's employment base has gravitated from relatively higher-wage manufacturing jobs toward relatively lower-wage service and tourism economy jobs. The Providence metropolitan region experienced the most dramatic declines in incomes, whereas Washington County, in the southwestern coastal region of the state, experienced dramatic income growth from 1989 to 2003 (Federal Reserve Bank of Boston, 2004). Mirroring the rest of the United States, Rhode Island's cities and urban environments are getting poorer, and the less-urbanized coastal counties are getting richer, fueling sprawl patterns in coastal development.

Rhode Island serves as a living laboratory for coastal governance reforms because of its small size, progressive environmental management systems, and unique historical and contemporary orientation to the coastal marine environment. It is therefore possible to identify and address key coastal issues by formulating, adopting, and implementing new policies and management approaches relatively quickly. For more than three decades, Rhode Island Sea Grant has drawn from its field experience in Rhode Island and beyond to identify the practices that generate progress towards sustainable coastal communities, resources, and ecosystems in a host of contexts. Based on Rhode Island Sea Grant's organizational glocal strategy, even greater emphasis will be placed on identifying issues and designing initiatives that are important locally and also relevant nationally and internationally. As a microcosm of the U.S. coast, Rhode Island is particularly well suited for this approach to programming.

Rhode Island Sea Grant's Strategic Investments in Sustainable Coastal Communities and Ecosystems

Sustainable Coastal Communities

For 2006 to 2010, the SCCE Program will focus on instituting ecosystem-based management of urban coastal ecosystems. Largely a SCCE Extension Program initiative, a primary strategic priority will be to spearhead the development of a Special Area Management Plan (SAMP) for upper Narragansett Bay with additional funding from the R.I. Coastal Resources Management Council (CRMC) and in partnership with the cities of Providence, East Providence, Cranston, and Pawtucket. Upper Narragansett Bay runs from Gaspee Point and Bullock's Cove northward to the falls at the head of the Seekonk River and the tidal portions of the Woonasquatucket and Moshassuck rivers.

The SAMP development process provides an opportunity for Rhode Island Sea Grant to contribute to the sustainable growth and stewardship of a vibrant community around upper Narragansett Bay. This strategic priority has the following objectives:

- Facilitate urban waterfront and watershed development planning that explicitly recognizes economic and environmental sustainability
- Develop regional solutions to issues such as public access, brownfields, port redevelopment policy, marine debris removal, and natural hazard mitigation planning and recovery
- Better incorporate applied research to the development and implementation of the upper Narragansett Bay SAMP
- Help urban coastal communities to identify themselves as beneficiaries of coastal environmental resources and values

Marina Ecosystems Initiative

The recreational boating industry, with nearly 30,000 businesses, is a key component of the national economy. Boats and related products total more than \$25 billion in annual retail sales and provide direct jobs for 550,000 workers nationwide who, in turn, generate multiplier effects throughout the economy with their expenditures. While the economic benefits that accrue to coastal communities from the marina industry are impressive, it is difficult to gauge what the future holds. There are emerging factors that will enhance waterfront access and recreational boating, such as port revitalization, and others that threaten their economic viability, like fewer government dredging dollars and displacement due to other forms of coastal development. These factors are exacerbated by pressure to increase environmental standards coupled with daunting regulatory guidelines. The National Sea Grant Network's Ecosystems and Habitats Theme Team is responding to these challenges by renewing and expanding on historical Sea Grant partnerships with the Marine Operators Association of America (MOAA), the National Marine Manufacturers of America (NMMA), BoatUS, and the Marina Education and Environmental Foundation (MEEF). Rhode Island Sea Grant will play a lead role over the next several years in helping the National Sea Grant Network formulate and implement a Marina Ecosystems Initiative.

Currently, 17 states are either developing or implementing clean marina programs. These programs evolved from an Environmental Protection Agency (EPA)-NOAA effort to reduce nonpoint source pollution through the use of best management practices (BMPs) by marina owners, boatyards, and boaters. Sea Grant is involved in the majority of these programs through research and extension activities. In spite of this effort, information is scattered and not readily accessible to the industry or other practitioners. As funds for environmental management shrink, effective implementation of clean marina programs will become more important. The economic value of BMPs has been amply demonstrated through numerous public and private marina case studies.

In terms of coastal ecology, these case studies have illustrated how some marina efforts may enhance the environment, such as shellfish aquaculture practices or naturalized shoreline protection systems. A broader and more comprehensive scientific evalua-

tion of the ecological benefits due to these and other clean marina practices is urgently needed to help the marina industry function as a green industry.

Additionally, there is an urgent need to develop low-cost methods of dredged material disposal (Costa-Pierce and Weinstein, 2002). This need, combined with the desire to restore wetlands as healthy ecosystems, provides an opportunity for future research. Building on the work done to date on beneficial use of dredged material, there is a need to synthesize information and provide specific guidance to the industry, while working to expand the research and technology efforts to improve the viability of alternative options in dredge management and disposal.

Rhode Island Sea Grant will work with other Sea Grant programs and the boating industry nationally to pursue the following broad activities:

- Develop a Marina Ecosystems Extension Network that will build capacity and strengthen the marina industry—a key Sea Grant constituent in coastal states and the Great Lakes region
- Initiate a Clean Marina Information Clearinghouse that will be a knowledgemanagement system for clean marinas in collaboration with the Sea Grant Network, MEEF, EPA, NOAA, and other representatives from the industry
- Quantify the effectiveness of BMPs, in terms of ecological and economic benefits
- Promote habitat creation and restoration in coordination with the recreational boating industry

Coastal Ecological Sciences

An ecosystem-based approach to marine science is increasingly recognized as essential and is strongly recommended in the 2004 report of the U.S. Ocean Commission on Ocean Policy, the current NOAA strategic plan, and the National Sea Grant College Program strategic plan. Rhode Island Sea Grant has long emphasized the importance of ecosystem-based natural and social science research and has made major contributions to knowledge of coastal ecosystem processes as well as to more informed management of our estuaries, coastal bays and lagoons, and urbanizing coasts.

As one of the most densely populated coastal states, Rhode Island is among the first to see the impact of human development and exploitation of coastal and marine resources. We have witnessed the impact of increased loadings of toxic metals, organic hydrocarbon, and sewage pollutants from the industrial revolution and post-war suburban sprawl as well as more recent declines in these loadings. We have pioneered the use of multidisciplinary science, computer models, and mesocosm research facilities to better understand the impacts of such shifts in the drivers of ecosystem change. We are in the initial stages of major environmental change for which Rhode Island may be the bell weather. Global climate change interacts with local environmental processes and activities, such as changes in productivity and nutrient loadings, to significantly alter Rhode Island's coastal ecosystems. Potential changes to the basic trophic status due to reductions in point source nutrient inputs to coastal ecosystems are not well understood. Moreover, basic research is needed on the effects of reducing inorganic nitrogen, a potent bio-stimulant, on the biogeochemistry of coastal systems.



"We produce food for a hungry planet, and we'd like that to be considered a noble pursuit."

— Henry Copestake, 2004 International Responsible Fishing Symposium,
Providence, R.I.

Over this strategic planning period, Rhode Island Sea Grant priorities in coastal ecosystems will concentrate on assessing the impacts of nitrogen reductions to Narragansett Bay ecosystems and determining the links between climate change and hypoxia/anoxia with regard to the ecological functions of Rhode Island's coastal waters. Specific priorities are to:

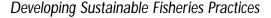
- Establish baselines for assessing the ecological impacts of significant reductions in point source nitrogen discharges to upper Narragansett Bay
- Develop methods for accurately quantifying secondary production rates in Narragansett Bay. Rhode Island Sound, and Block Island Sound
- Apply stable isotope ratio analysis to determine the sources of nitrogen discharges to upper Narragansett Bay especially with regard to sewage-derived nitrogen
- Determine the presence of ecological gradients in Narragansett Bay that may have emerged as a consequence of significant nitrogen inputs and frequent hypoxia in upper Narragansett Bay
- Assess the degree to which the entire Bay (versus just the upper Bay) will respond ecologically to a projected 25 percent reduction in total nitrogen discharges
- Assess the impacts of varying dissolved oxygen concentrations and temperature changes on biogeochemical cycling of nitrogen in the benthos, particularly nitrification and denitrification rates
- Quantify the shallow-water habitat impacts of low dissolved oxygen and significant changes in long-term average temperature
- Assess changes in the timing, frequency, and duration of phytoplankton blooms in Narragansett Bay and the ecological impact on benthic and planktonic species communities of such major alterations in primary productivity pulses

Sustainable Fisheries

America's Fisheries Challenges

Fisheries are the largest extractive use of wildlife in the world. Fisheries products are the primary protein sources for almost 950 million people worldwide (Costa-Pierce et al., 2002). In 2000, landings from the 70,000 U.S. commercial fishing vessels totaled 9.1 billion pounds with a gross revenue of \$3.5 billion dockside and contributed more than \$27.8 billion to the gross national product (GNP). Commercial fisheries employ more than 170,000 people in the United States, the majority in family-owned and operated businesses. The U.S. commercial fleet is the fourth largest in the world. In addition, the 10 million U.S. recreational fishermen harvested over 254 million pounds of fish and shellfish or 75 million fishing trips, contributing \$25 billion to the GNP (Hogarth, 2002).

Despite the socioeconomic importance of fisheries nationally and globally, marine fisheries science and management continues to be buffeted with controversy and uncertainty. Recent reports issued by Beach (2002), Myers and Worm (2003), and the Marine Fish Conservation Network (2003) paint a dismal picture for Northeast fisheries, but NOAA (2003) and the U.S. regional fishery management councils continue to state that many important commercial stocks are recovering, and that federal, regional, and state management processes are achieving their legally mandated conservation and recovery objectives. For the 163 stocks for which data are available and their status known with reasonable certainty, NOAA Fisheries considers 40 percent to be overutilized and 17 percent underutilized, while the status of an additional 68 commercial stocks and the impacts of intensifying recreational fishing are little known. Coincident with these disputes among nongovernmental organizations, scientists, and fisheries managers, the commercial and recreational fishing industries are struggling to find ways to maintain economic and social solvency within a more restrictive, and less predictable, management regime.



The foundation of fisheries management begins with the science of fish ecology and biology, which forms the basis for developing meaningful harvesting strategies. Single-species management approaches are being replaced with ecosystem-based management approaches, incorporating known food chain dynamics, species interactions, and relationships with the physical, chemical, and biological functions of the marine environment. Fisheries may be viewed as the interaction among the fishing gear, fish, harvesters, processors, and consumers. In the past decade, the effect of fishing on habitat has been identified as an important aspect of these activities. Essential fish habitat (EFH) has been identified as an important component to understanding fish population dynamics.





USC SEA GRANT STRATEGIC THEMATIC AREAS

WATER QUALITY AND COASTAL ECOSYSTEMS

Vision

A healthier urban ocean environment. reflected in cleaner coastal waters that afford better opportunities for recreation and commerce and the protection of human and ecosystem health.

Background

Intense urban development and the recreational activities of millions of Californians Page 18 living in the coastal region have seriously altered and impacted the near-shore and off-shore ecosystems of the Southern California coastal zone Wetlands have been filled in, and rivers and streams turned to concrete, resulting in rapid delivery of massive amounts of urban contaminants to recreational beaches and marine habitats. Channelized rivers and streams serve as direct conduits for runoff into the ocean, even during dry weather. Recurrent cycles of fires and floods cause high sediment and nutrient loads which flow into the coastal ocean. These non-point sources of pollutants are difficult to manage and present a wide range of unknown problems for both ecosystems and public health



Researchers from California State University Long Beach deploy nets at Seal Beach to capture and tag stingrays.

Potential hazards to public and ecosystem health from these inputs result in frequent water quality warnings or beach postings throughout Southern California. State and federal laws mandate testing waters to determine if the contamination standards have been exceeded. Standard bacterial monitoring tests for the presence of fecal coliforms, total coliform and enterococuus, but does not indicate the actual presence of pathogens potentially harmful



to human health. While bacterial indicators are currently considered the best indicators of public health risk, it would be preferable to managers and scientists to find the pathogens most likely to cause illness and to have testing methodologies that provide authorities with the information on those pathogens in sufficient time to warn the public.

The Southern California region has one of the largest sewage effluent systems in the country: more than 1 billion gallons per day reach the ocean from the White's Point (Los Angeles County), Hyperion (Los Angeles City) and Orange County sewage treatment plants, and Point Loma (San Diego County) sewage treatment plant contributes another 300 million gallons more per day. Pollution problems

THESE NON-POINT SOURCES OF POI-LUTANTS ARE DIFFICULT TO MANAGE AND PRESENT A WIDE RANGE OF UNKNOWN PROBLEMS FOR BOTH ECOSYSTEM AND PUBLIC HEALTH.

in this region can be severe. For example, before it was outlawed in the 1960s, over 200 metric tons of DDT was deposited in the sediments of the Palos Verdes Shelf, creating significant impacts on the coastal marine ecosystem, which persist to the present time.

This is important because it is not only the public's health that is at risk but also the health of marine ecosystems. People can protect themselves by avoiding the water when it has been contaminated, but the organisms that live in the marine environment do not have this choice. The only way to fully protect the fragile marine ecosystem is Page 19 to prevent the influx of pollution. Achieving such protection continues to challenge scientists working to accurately identify and eliminate the influx of non-point source pollution. Baseline data for present-day Southern California marine ecosystems and working models of the structure and dynamics of these ecosystems are needed to assess both natural and human induced changes. Furthermore. studies must advance beyond single species management and invest in long term ecosystem-level research to better understand the complex interacting factors critical to healthy ecosystems and restoration of degraded habitats.





Protecting Public Health

Goal

Page 20

 Protect public users from potential health risks associated with swimming in coastal waters, consuming seafood, and other recreational users.

Objectives

Develop better rapid water quality indicators and source tracking tools.

Develop methodologies to decrease risk of human illness through consumption of contaminated fish and shellfish.

Identify and determine effects of contaminants and biological agents of concern to human health and the health of marine organisms. Create mechanisms, e.g. geographic information systems (GIS) for simplifying the distribution of water quality information for policymakers and the public.

Develop unique tools for informing the public about health risks related to coastal recreation (i.e., swimming and consuming seafood) in areas of poor water quality.

Make better information on water quality and coastal ecosystem health and dynamics more readily available to local governments to improve policies and management decision making.

THE ONLY WAY TO FULLY PROTECT THE FRAGILE MARINE ECOSYSTEM IS TO PREVENT THE INFLUX OF POLLUTION.

Understanding Pollution

Goal

2. Improve understanding of the content, fate, and effect of point and non-point source discharges in urban watersheds.





Objectives

Identify and evaluate the sources and processes controlling behavior, fate and impact of pollutants in aquatic systems.

Investigate groundwater, including septic system, contributions to near-shore pollution.

Understand the role of wetlands in mitigating storm water flow and clarify the importance of wetlands water quality to the wetland ecosystem.

Assess the presence of contaminants in aquatic ecosystems; assess effects and potential mitigation measures.

Develop methods to accurately determine the assimilative capacity of receiving waters.

Help develop architectural design principles for runoff mitigation planning and inform the public about sustainable development design.

Assessing Impacts on Marine Life

Goal

Develop new methods and approaches for assessing the conditions (health, changing distributions and abundances) of coastal marine life.

Objectives

Assess the impacts of urban storm-water pollution on the near-shore marine environment.

Determine responses of marine organisms to contaminants and pathogens.

Develop effective bio-indicators of contamination.

Understand marine life-habitat interactions at the local level and improve understanding of population ecology for habitats important to Southern California.



Determine the patterns, causes, and implications of changes in coastal populations of marine species and marine biodiversity in response to ocean regime shifts and naturally occurring events such as El Nino Southern Oscillation (ENSO).

Understanding and Protecting Ecosystems

Goal

Page 22

4. Improve understanding of the dynamics of coastal ecosystems in urban watersheds, as they respond to ocean climate change and other natural events as well as to anthropogenic activities.

Objectives

Investigate and assess the contribution and impacts of aerial deposition and impacts of contaminants to aquatic systems.

Support observations and studies of longterm trends and effects of oceanic events such as sea surface warming, sea level rise and anthropogenic activities such as introduction of exotic species.

Determine the reach and/or range of urban impacts on coastal ecosystems.

Accurately determine source contributions and effective methods to reduce loadings. to contribute to the identification of Total Maximum Daily Loads (TMDL's) for municipal and state authorities.

Improve understanding of the impacts of invasive species, harmful algal blooms and artificial reefs

Determine the effects and effectiveness of Marine Protected Areas (MPA) including socioeconomic effects, and develop methods and approaches for MPA evaluation.

SOCIETY AND COMMERCE

Vision

Balance the robust economic opportunities of the ocean with safeguards to ensure the continued sustainability of marine resources.

Background

The coastline has become host to a wide range of uses: huge seaports, millions of beachgoers on more than 100 miles of sandy beaches, commercial and recreational fishing docks and fish markets. sewage-disposal plants and electric generating stations, residential use, and military facilities, all present coastal planners and managers with an almost insurmountable array of conflicts and issues. Since World War II the area has become the major West Coast seaport yet it has also supported an increasing population of residents and visitors. Accompanying economic growth of the area has been competition for uses of the coastline for housing, recreation and commerce.

California's ports and harbors are a central component of the coastal economy of the region. Ninety-five percent of international trade arrives by sea into United



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States ports, and Southern California is home to the two largest commercial ports in the country. In all, California's six major ports (Oakland-San Francisco, Los Angeles-Long Beach, Port Hueneme and San Diego) process about 70% of all ocean freight handled on the West Coast (by tonnage). The Ports of Los Angeles and Long Beach have the third largest volume of imports and exports in the world; moreover, cargo loads are anticipated to triple by the year 2020. The impact of this growth will affect air quality, water quality, the land transportation system and the area's population. Port managers and environmental regulators

FOCUS AREAS

Over the next five years, Sea Grant will concentrate effort in four areas: healthy coastal ecosystems; sustainable coastal development; a safe and sustainable seafood supply; and hazard resilience in coastal communities. These four interrelated focus areas emerged from the strategic planning process as areas of critical importance to the health and vitality of the nation's coastal resources and communities. They respond to issues of major importance to NOAA, are consistent with the work of the NOAA coastal program integration effort, and are topical areas in which Sea Grant has made substantial contributions in the past and is positioned to make significant contributions in the future.

In each of the four focus areas, Sea Grant has identified goals it will pursue and strategies designed to take advantage of its strengths in integrated research, outreach, and education and its established presence in coastal communities. Understanding relationships and synergies across focus areas is vital to achieving the focus area goals. Sea Grant is only one of many partners working to address these complex and interrelated issues. Looking for how activities in one area of endeavor can support and complement other activities and using partnerships to accomplish shared goals are inherent in how Sea Grant programs function and will be central in achieving the goals outlined in this plan.

HEALTHY COASTAL ECOSYSTEMS

Healthy costal ecosystems are the foundation for life along the coast, but increasingly rapid coastal development, global overfishing, and other human activities are leading to water quality degradation, decline of fisheries, wetlands loss, proliferation of invasive species, and a host of other challenges that need to be understood in order to restore and maintain these ecosystems. Ecosystem functioning does not respect traditional political boundaries and responsible management of ecosystems requires new kinds of thinking and actions. Sea Grant is a leader in regional approaches to understanding and maintaining healthy ecosystems, with planning efforts underway across the country to identify information gaps, set research priorities, and coordinate information and technology transfer to those who need it. It has fostered efforts to address widespread problems such as invasive species and harmful algal blooms that are found in geographically dispersed areas and has hired staff, shared among several state programs, to tackle these problems. Sea Grant's regional consortia, nationwide networks, and international contacts are particularly well suited to helping the nation address ecosystem health at the appropriate local, state, regional, national and global levels.

Goal: Sound scientific information to support ecosystem-based approaches to managing the coastal environment.

To realize the full potential of ecosystem-based management approaches we need research that will lead to better understanding of present day conditions, basic ecosystem processes, the impacts of coastal and upland land uses on the health of coastal, ocean and

Great Lakes environments, and the importance of healthy ecosystems to healthy fisheries. We also need to know more about how to transform our new knowledge and understandings into sound management principles and practices. Sea Grant will continue to build the scientific foundation needed by supporting research that provides accurate information related to ecosystem health and by accelerating the transfer of this information to coastal residents, resource managers, businesses and industries.

Strategies

- Conduct research on ecosystem processes, the relationships between coastal stressors--water quality degradation, contaminants, harmful algal blooms, invasive species, and wetlands loss--and long-term human and ecosystem health, and communicate this information to public and private planners, decision-makers and managers.
- Contribute to the development of baseline data, standards, and indicators to support ecosystem-based approaches to land use, water, fisheries, and other resource management, working with programs such as NOAA's National Centers for Coastal Ocean Science, ocean observing programs, and others.
- Develop methodologies that can be used to evaluate ecosystem-based management approaches to assess their effectiveness once they are in place, and to guide future management efforts, working with the National Marine Fisheries Service and other federal, state and local partners.

Goal: Widespread use of ecosystem-based approaches to managing land, water and living resources in coastal areas.

Achieving widespread use of ecosystem-based management approaches will require extensive efforts to communicate the effects of ecosystem degradation on natural resources, local economies, and human health to a wide range of audiences in ways that motivate them to respond. Sea Grant's strong research and extension capabilities provide scientific information and technical assistance on ecosystem-based management approaches. At the same time, the organization's outreach and education capabilities engage citizens in stewardship activities that promote healthy ecosystems. All these programs can result in regional and other collaborative approaches to address problems that extend beyond traditional geographic or governmental boundaries.

Strategies

 Work with partners inside and outside NOAA to develop data, models, and training activities that support ecosystem-based planning and management approaches, and share these with a wide variety of constituencies.

- Support the development of regional coastal observation systems and other collaborative efforts that advance our capability to predict the effects of human activities and environmental changes on coastal resources in order to take steps to mitigate their effects.
- Provide life-long learning programs for people of all ages that enhance understanding of coastal, ocean and Great Lakes environments and promote stewardship of healthy ecosystems.

Goal: Restored function and productivity of degraded ecosystems.

Past activities and events have led to deterioration of nursery areas for wild fish populations, loss of wetlands, closure of beaches and shellfish beds, and proliferation of invasive species. Sea Grant will help reverse these trends by identifying and assessing impaired ecosystems and supporting the development of new policies, technologies, and processes that promote restoration of ocean, coastal, and Great Lakes ecosystems in ways that balance the needs of the natural systems with the needs of the humans that inhabit them. Sea Grant will use its nationwide network of extension, education and communication specialists to provide the technical assistance needed and to share new information and technologies with local, state, regional, national, and international partners.

Strategies

- Support research to improve the effectiveness of ecosystem restoration and identify promising new restoration approaches and technologies.
- Invest in the development and dissemination of new information, policies, technologies and methods to address water quality degradation, prevent the introduction and spread of aquatic non-native species, and minimize the negative impacts of these on coastal, ocean and Great Lakes food webs.
- Provide technical support for citizens and businesses that need help with specific mitigation/restoration problems, giving them access to the latest information and techniques.

SUSTAINABLE COASTAL DEVELOPMENT

Coastal communities in America provide vital economic, social, and recreational opportunities for millions of Americans, but decades of population migration have transformed our coastal landscapes and intensified demand on finite coastal resources. The increase in population has resulted in new housing developments and recreation facilities, a new generation of energy development activities, port expansions, and other business activities. These changes are placing tremendous pressure on coastal lands,

water supplies, and traditional ways of life. To accommodate more people and activity and to balance growing demands on coastal resources, we must develop new policies, institutional capacities, and management approaches to guide the preservation and use of coastal, ocean and Great Lakes resources. Sea Grant will engage a diverse and growing coastal population in applying the best available scientific knowledge and use its extension and education capabilities to support the development of healthy coastal communities that are economically and socially inclusive, are supported by diverse and vibrant economies, and function within the carrying capacity of their ecosystems.

Goal: Healthy coastal economies that include working waterfronts, an abundance of recreation and tourism opportunities, and coastal access for all citizens.

Marine resources and coastal amenities sustain local and national economies through fisheries and aquaculture, seafood processing, trade, energy production, tourism, and recreation enterprises. Urban ports and waterways continue to accommodate expanding international trade, staging areas for off-shore industries, growth in tourism and recreational boating, and changes in fishing fleets. At the same time, changing development patterns along the coast are threatening to displace traditional water-dependent industries and cut off water and beach access for coastal residents. Vacant industrial buildings and obsolete infrastructure facilities can be recaptured for new marine enterprises, public access, and planned mixed-use developments that bring enjoyment to residents and visitors alike. Sea Grant's long-standing relationships with coastal communities and industries make it ideally suited to provide information, tools, and techniques to support working waterfronts, responsible energy development, the development of accessible recreation and tourism activities, and adoption of sustainable development practices

Strategies

- Support research and outreach activities that provide local communities with information and techniques to help them enhance their waterfront-related economic activities such as commercial and recreational fishing, aquaculture, tourism, and energy and port development, without diminishing the long-term health of the natural coastal environment.
- Support local, regional, and national efforts to preserve and increase public access to the nation's beaches and waterfronts through assessment of access needs, analysis of legal issues, and technical assistance.
- Use Sea Grant extension and education capabilities to engage coastal communities in planning processes that support the efforts of community leaders to identify and pursue sustainable economic development policies and programs.

Goal: Coastal communities that make efficient use of land, energy and water resources and protect the resources needed to sustain coastal ecosystems and quality of life.

The biggest challenge facing many coastal cities and towns today is how to manage growth in ways that do not diminish the health of the ecosystems these communities depend on. One way this is reflected nationally and internationally is in the high-level of concern about climate change and its associated effects. To respond to the challenges of growth at a local and regional level, communities are looking for ways to use land and water, generate energy, and dispose of waste that will preserve environmental health and economic vitality. Determining the amount of the land, water, and other natural resources needed to sustain healthy communities is an essential first step in establishing sustainable policies and growth practices. Only when the dimensions of this environmental footprint are identified can coastal communities understand what their carrying capacity is and what will be needed for generations to come. Sea Grant and its university partners are in a unique position to conduct research and develop models and forecasts that will help communities with this process.

Strategies

- Strengthen Sea Grant's research activities and extension capacity to help coastal communities determine the sustainable carrying capacity of their land, water, and other resources through resource assessments, scenario building, modeling, and other techniques.
- Support innovative research on land-use practices and building designs that promote energy and water conservation, coastal-ocean related renewable energy technologies, and the creation of other tools to help communities grow in sustainable ways.
- Work with NOAA's Climate Program Office, coastal programs, and other
 partners to help communities evaluate their ecological footprints and grow in
 environmentally sustainable ways.

Goal: Coastal citizens, community leaders, and industries that recognize the complex inter-relationships between social, economic and environmental values in coastal areas and work together to balance multiple uses and optimize environmental sustainability.

According to NOAA's <u>Population Trends Along the Coastal United States: 1980-2008</u>, coastal counties constitute only 17 percent of the land area of the U.S. (not including Alaska) but account for 53% of the population and are among the most rapidly growing areas in the country. The pressures on our oceans, coasts, and Great Lakes resources continue to grow. Citizens and decision-makers have an urgent need for tools that will help them evaluate the implications of land use changes, coastal development pressures,

and increased resource use in approaching the policy and management decisions they face. Regional cooperation and coordinated land use and watershed planning are essential. Sea Grant's well-established role as a trusted broker among a wide range of interests makes it a key player in providing sound information for decision-makers, convening stakeholders to seek common ground, and facilitating the development and implementation of new coastal policies, plans, management approaches, and consensus building strategies.

Strategies

- Work with NOAA's Office of Ocean and Coastal Resource Management and Coastal Services Center, EPA's Offices of Smart Growth, and other federal, state and local partners to disseminate assessment tools, model plans and ordinances, best management practices, alternative development approaches, and other techniques that will enable the citizens of our coastal zones to develop their coastal economies in environmentally sound ways.
- Build local capacity to evaluate cost-benefit trade-offs in the coastal zone through a greater emphasis on socio-economic research, impact studies, and other other methods of evaluating alternative future scenarios for coastal communities.
- Foster regional cooperation and partnerships among local government officials, community stakeholders, and regional planning organizations to promote sustainable growth plans and strategies that protect local and regional natural resources that will ensure that an abundance of these resources is available to serve future generations.

SAFE AND SUSTAINABLE SEAFOOD SUPPLY

The U.S. has witnessed the decline of many of its major fisheries while seafood consumption is on the rise, resulting in a seafood trade deficit of \$8 billion per year, according to U.S. Department of Agriculture Foreign Agricultural Service statistics. At the same time, Sea Grant, through its research, extension, and education activities and work with partners, has resulted in important discoveries that have aided the stabilization and recovery of many endangered fisheries. According to the NOAA Aquaculture Program, aquaculture is in its infancy in the U.S., amounting to just over \$1 billion of a \$70 billion worldwide industry. Aquaculture creates important new opportunities to meet the increased demand for seafood but a number of questions need to be addressed for its full potential to be realized. Seafood safety is a growing concern as international trade increases and fish diseases and contamination become bigger problems. Sea Grant has key roles to play in advancing public understanding of the nature of these problems and opportunities. Through the use of its research, extension, and education capacities, Sea Grant will support the kind of informed public and private decision-making that will lead to a sustainable supply of safe seafood long into the future.

Ecosystem Health

Understanding the marine environment and protecting it from the deleterious effects of human activities, including contamination from terrestrial and ship-borne sources, degradation of nearshore, upland and open-water habitats, overharvesting of fish, shellfish, algae and invertebrates, and introductions of invasive plant and animal species.

To understand marine and coastal systems and the changes that are taking place in them, it is important to describe these systems and document biodiversity within them. WSGP studies are process-driven and focus on many levels of the natural food web, rather than concentrating only on food fish and top predators. These studies allow for the identification and harvest of organisms and cellular products from the oceans. Descriptions and models of natural systems lead to better understanding of the impacts of conservation and exploitation of resources and the development of improved tools for ecosystem management.

Areas of interest to WSGP for strategic investment include: bioremediation; harmful algal blooms; functions and values of fish and wildlife habitat; development and assessment of restoration techniques; non-indigenous species invasions; oil spill prevention education; water quality; habitat; potential impacts of global climate change; the use of estuarine and marine protected areas as laboratories for understanding ecological processes and environmental change; and development of training workshops and educational materials on ecosystem health for K-12 students and community groups.

GOAL EH1

Understand the coastal, estuarine and marine environment of Washington state and the Pacific Northwest and improve the management of coastal marine resources.

Objective EH 1.1

Describe the coastal and estuarine environment through research studies and assessments, to better understand interactions of marine resources and their environment.

Objective EH 1.2

Develop models of coastal and estuarine systems to develop better management tools and to better understand the impacts of human activities, including exploitation and conservation of resources.

Objective EH 1.3

Develop environmental indicators and evaluation criteria for management of the coastal ecosystems of Puget Sound and the Washington coast.

Objective EH 1.4

Develop information and models that assist in management of Pacific Northwest ecosystems, including alternative management approaches, and make results of estuarine and coastal research accessible and useful for resource managers and the public.

GOAL EH 2

Protect the integrity of marine, coastal and estuarine **habitats** from the effects of physical alteration, with particular emphasis on nearshore habitats.

Objective EH 2.1

Describe the extent and condition of estuarine and coastal habitats, and the impacts of physical alteration.

Objective EH 2.2

Develop tools and techniques to understand and improve the efficacy of habitat restoration and to characterize, protect and enhance critical habitat for endangered species.

Objective EH 2.3

Provide access to new habitat restoration and enhancement tools and techniques, as well as inventories of estuarine and coastal habitats for resource managers.

GOAL EH 3

Protect the marine environment of coastal Washington from contamination due to human activities and periodic natural disruptive events.

Objective EH 3.1

Identify and promote solutions to the impacts of biological and chemical contamination in nearshore waters and on resource populations.

Objective EH 3.2

Develop better assessment capabilities, analytical techniques and models to address current and emerging water quality concerns.

Objective EH 3.3

Investigate the causes and management of Harmful Algal Blooms to ensure the health of the ecosystem and to protect public safety.

GOAL EH 4

Minimize the introduction of nonindigenous species and manage for established populations of aquatic invasive species.

Objective EH 4.1

Understand the invasion potential and critical pathways for the introduction of non-indigenous species that are most likely to become aquatic invasive species.

Objective EH 4.2

Develop tools and techniques to understand the impact of ballast water introductions to coastal waters from coast-wide and overseas shipping.

Objective EH 4.3

Minimize the introduction of non-indigenous species through education and training.



Strategic Plan 2004-2010 17



FISHERIES AND AQUACULTURE

In Fisheries and Aquaculture, Woods Hole Sea Grant has identified two priority areas that best fit within the region's academic and research environment: revitalizing our nation's fisheries and development of sustainable aquaculture. In New England, these areas are very closely linked technologically and culturally. Thematic elements include:

- Development of technology and programs to promote stock enhancement of natural fish and shellfish resources, including mechanisms to evaluate the efficacy of enhancement programs and the overall effectiveness of such programs;
- Investigation of larval recruitment processes for fish and shellfish and development of means to understand the relationship between recruitment and physical and chemical characteristics of the environment;
- Investigation of disease processes in marine organisms with an emphasis on prophylactics and management of diseased stocks to minimize economic losses to the natural fisheries and aquaculture industries; and
- Promotion of business and industrial development through expanding efforts in coastal management and through understanding of the economics of marine related businesses.

Vision:

There will be a diverse and healthy fisheries resource, particularly shellfish, in the southeastern Massachusetts region.

GOAL 1: To maintain and improve marine and estuarine habitat important to commercially important wild resources.

Objective: Implement an eelgrass planting/restoration program to improve habitat conditions for commercially important shellfish species in the region.

GOAL 2: To enhance, restore and/or maintain wild populations of commercially important resources.

Objective 1: Test and compare various methods of restoration of bay scallops, and implement the most promising methods to measurably improve local bay scallop harvests.

Objective 2: Implement remote set technology on a regional scale to restore and enhance native oyster populations to improve oyster harvest and create a diverse habitat for associated marine organisms.

Vision:

The aquaculture industry in southeastern Massachusetts will become more diversified and more competitive in a global economy.

GOAL: To develop new candidate farmed species and to apply new farming technologies appropriate for southeastern Massachusetts within the bounds of minimal environmental impacts.

Objective 1: Explore the culture potential of underutilized shellfish species, such as razor clams and soft shell clams, in southeastern Massachusetts.

Objective 2: Quantitatively compare various types of culture methods and equipment in terms of survival, growth, cost effectiveness and environmental impact.

Vision:

Science-based decisions will promote healthy natural ecosystems while allowing economic development that is culturally significant within the region's coastal environment.

GOAL: Stakeholders in the southern New England region will use knowledge gained from Woods Hole Sea Grant programs to promote science-

based decision-making.

Objective 1: Provide a means to translate science and technology into applications relevant to southeastern Massachusetts and relay that information to appropriate user groups.

Objective 2: Educate stakeholders in southern New England who will promote sustainable, environmentally sound policies.



What people are saying about William Walton, Woods Hole Sea Grant Fisheries and Aquaculture Specialist—

Thanks so much for coming out to be in our EstuaryLive production. You were great—excellent descriptions, lots of props and hands-on opportunities for close-ups.

—Joan Muller, Education Coordinator, Waquoit Bay NERR

Thanks for getting in the pond with us, helping to save some oysters for harvesting. And those fresh oysters were delectable...

—From the Corps members of AmeriCorps Cape Cod, Class VI

The Bourne Shellfish Working Group (BSWG) would like to thank you for being a panel member [for] our discussion about shellfish transfers and relays at our May meeting. We had a lot of expertise on the panel, good questions and comments from the attendees, and excellent information from the panel members. We had nothing but good comments about the meeting and hopefully we can do it again sometime during the fall or winter...

-Win McLane, Chair, BSWG



What people are saying about Jim O'Connell, Woods Hole Sea Grant Coastal Processes Specialist—

Thank you again for your contribution to the "On the Waterfront Institute." You are a true find—a passionate and inspiring scientist who also understands the needs of teachers and the minds of middle school students, and how to communicate to all of the above effectively! We look forward to more opportunities for collaboration.

-Sukey Padawer,

Senior Program Developer/Educator New England Aquarium

Thank you so much for sharing your knowledge about coastal processes with the Barnstable Middle School students and bringing it to a level that they were able to understand. AmeriCorps members also enjoyed your presentation. We learn something new from you every time we see you!

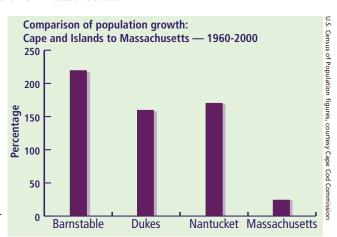
-AmeriCorps Cape Cod

COASTAL PROCESSES

Coastal ponds, estuaries, embayments, open coasts, and coastal resources are highly impacted by society's commercial, recreational, and residential activities. In southeastern Massachusetts, development in coastal communities was among the highest rate of increase within the Commonwealth of Massachusetts.

The population of Barnstable County (Cape Cod), Dukes County (Martha's Vineyard), and Nantucket County has been dramatic when compared to overall population growth in the Commonwealth.

Other threats to coastal communities include sea-level rise, erosion, conflicts between the protection of waterfront property and the preservation of the beneficial functions of



coastal landforms and resources, conflicts between private ownership of the coast and public access, and recreational demands of the increasing coastal population (boating, fishing, shellfishing, beaches). Research supported within this theme is often multidisciplinary and interfaces directly with the management community charged with making regulatory decisions.

Vision:

Science-based decisions will lead to more naturally appearing and naturally functioning coastal landforms and littoral systems, while balancing impacts of living along the shore.

GOAL 1: Stakeholders will use science-based information to make more informed decisions about coastal land use issues.

Objective: Increase the availability of science-based information for coastal residents, managers, stewards, and decision-makers regarding protection, prediction, risk reduction, and economic impacts associated with living along the shore.

GOAL 2: Stakeholders will maximize use and enjoyment of coastal resources while minimizing human impacts on the beneficial functions of coastal landforms and coastal processes.

Objective: Stakeholders will have scientific-based information to make more informed decisions about land-use issues, particularly regarding coastal landform function and coastal processes.

Environmental Technology

Woods Hole Sea Grant's Environmental Technology theme focuses on the initiation of research projects that will develop and deploy innovative technologies to address specific problems in coastal ecosystems; and the development of extension and outreach activities to foster information transfer, education, and development of new monitoring and treatment technologies. Thematic components include:

- Marine biotechnology, including the development of molecular markers for understanding contaminant effects in the environment and probes for application to ecological processes;
- Remediation technologies, including the development of new approaches to understanding the degradation of contaminants in the environment; and

Vision:

New technologies and

tools will allow improved

capabilities for prediction of

environmental changes, leading

to protection of resources in

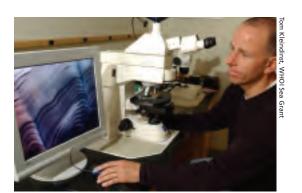
coastal ecosystems.

■ Remote technologies for monitoring the marine environment.

GOAL: New tools and technologies will be deployed that can be applied to predicting and monitoring changes in environmental variables and protecting resources in coastal ecosystems.

Objective 1: Principal investigators will conduct research projects that will develop and deploy innovative technologies to address specific problems in coastal ecosystems.

Objective 2: Extension and outreach staff will develop programs to facilitate information transfer about the development of new treatment and monitoring technologies.



Technology Aids Fishery Management

Assessing supply and balancing it with demand is no doubt one of the biggest challenges for fisheries managers. In California, the squid fishery is at or near maximum exploitation, and increasing values have resulted in added fishing pressure over the past decade. Complicating matters, squid have a 6-12-month life cycle, making successful annual recruitment to the fishery critical.

"Squid are being exploited at an unprecedented rate, especially in Monterey Bay," says Roger Hanlon, a scientist at the Marine Biological Laboratory who has studied squid behavior and reproduction for over 20 years. "Does it make sense to allow direct fishing of spawning squids before enough eggs are laid for next year's recruitment class?" he asks.

To answer that question, California fisheries biologists and NOAA Sanctuary managers first needed information about the location of primary egg beds and inshore spawning grounds. With Sea Grant support, Hanlon,

along with WHOI engineer Ken Foote, teamed up to marry technology and biology by designing an innovative project using sonar to locate squid eggs. Squids lay



their eggs—up to 200 of them—in fingershaped, gelatinous tubes. Female squids deposit the egg fingers into huge, communal egg masses, called mops. It turns out that side scan sonar can detect the presence of the egg mops, displaying them as dark spots on multi-beam bathymetry images taken from remotely operated vehicles. Investigators will refine the methodology and continue the survey of egg mass distribution in Monterey Bay on upcoming cruises in an effort to provide fishery and sanctuary managers with monitoring and stock assessment tools.

OUTREACH AND EDUCATION

I am writing to thank you for all [of the] helpful information I've attained through your booklet on marine science careers. I am a high school junior from St. Louis, and from my location I'm unable to access the ocean... Your website and booklet have helped [lead] me in the right direction. Thank you for taking the time to help people like me reach for their dreams.

-Katie

Thanks again for the invitation to participate in "Ocean Alive." I was impressed by the turnout and the inquisitiveness of the audience. It's rare that we get a chance to discuss these issues in a forum without the usual tensions that follow fisheries management. "Oceans Alive" is a unique program that bridges the gap between the science community and the general public. I have greatly enjoyed the series both as an audience member and participant.

—Steve Murawski.

Northeast Fisheries Science Center, NOAA NMFS

Although I teach in inner city Worcester, I will be able to adapt the information I learned to areas in and near the school's landscape. I am always looking for interesting lessons that integrate math and science. I like that it is hands-on learning—students have to collect data, document it, and work as a team.

—High School teacher, Worcester, MA
"Topics in Oceanography" teacher workshop

At Woods Hole Sea Grant, the goal of the Outreach, and Education theme is effective dissemination of Sea Grant information, research, and technology. By reaching out to audiences in an attempt to answer questions, increase environmental awareness, improve science literacy, and bridge the gap between marine research and an informed and knowledgeable public, the Sea Grant outreach effort is making significant contributions to citizens and organizations within the Commonwealth of Massachusetts as well as the northeast region and the nation.

Vision:

Massachusetts citizens will have an understanding of the role the oceans play in their lives, continue to seek information on coastal issues, and apply that knowledge to science-based decision-making.

GOAL: Citizens will have the tools to make connections between ocean science information and coastal and ocean decisions.

Objective 1: Citizens of southeastern Massachusetts will have multiple opportunities, in a variety of venues, to access Sea Grant research applicable to their interests and needs.

Objective 2: Coastal decision-makers will utilize Sea Grant research results and outreach products, and participate in training opportunities, to increase their ability to design environmentally sound policies.

Objective 3: Educators in southeastern Massachusetts will use ocean science examples, including Sea Grant funded research, to convey basic scientific concepts to their students.



www.marinecareers.net www.beachcomberscompanion.net

Aquatic Invasive Species

This theme is another Wisconsin Sea Grant priority area because of the significant threats to coastal and Great Lakes ecosystems as well as economic costs and human health risks posed by aquatic invasive species (AIS). From parasitic sea lampreys in the 1940s to zebra mussels in the 1990s, the Great Lakes in particular have been severely impacted by invasions of nonindigenous aquatic species. As of 2004, there were 162 confirmed invasive species in the Great Lakes. Since 1990, the Great Lakes have been invaded at a rate of one new aquatic species a year, and some studies indicate the rate of introductions is likely to increase in the future. As indicated below, the priorities in this cross-cutting theme are also priorities in other national Sea Grant themes

National Goals

- Understand AIS impacts on aquatic systems and our economy.
- Understand the biology of invasive species to develop effective means of prevention and control.
- Identify safer and more effective control strategies.
- Identify more effective and less expensive strategies to prevent new introductions.

Wisconsin Priorities

- Conduct research on the effects of invasive species on the Great Lakes ecosystem, including food webs, nutrient and contaminant cycling, and socio-economic implications. Develop predictive tools for understanding effects of future invasions.
- Develop scientific approaches to guide control practices for dealing with aquatic invasive species.
- Provide training to industrial and commercial partners on how to control the spread of AIS in their harvest and stocking activities. (*Aquaculture Theme*)
- Create biotechnological tools for addressing problems and issues related to AIS. (Biotechnology Theme)
- Develop monitoring tools and methods—including *in situ* as well as remote sensing technology, geographical information systems and computer modeling tools—for continuously tracking and assessing the nature and extent of AIS-related biological and physical changes in and Great Lakes ecosystems. (*Digital Great Lakes Theme*)
- Conduct research, outreach and education activities for deterring, identifying, eradicating and/or controlling invasive species, nuisance algae and aquatic toxins. (*Ecosystems & Habitats Theme*)
- Evaluate the biological and economic impacts of invasive aquatic species on the Great Lakes' fisheries, and develop scientific approaches to guide control practices for dealing with them. (*Fisheries Theme*)
- Discover and develop new, novel and beneficial uses for invasive aquatic species. (*Seafood Science & Technology Theme*)
- Assess the threats to human health and aquatic life posed by the introduction of exotic parasites, bacteria and other pathogens to the Great Lakes. (*Urban Coast Theme*)

Ecosystems and Habitats

Coastal areas provide essential habitat for 75% of U.S. commercial landings of fish and shellfish as well as critical habitat for numerous species of recreational fishes, waterfowl, migratory birds, amphibians and mammals. The continuing rapid urbanization of our coasts has destroyed a significant amount of coastal wetlands, degraded coastal water quality and severely stressed coastal ecosystems.

Nowhere is an understanding of the linkages between terrestrial and aquatic environments more critical to resource quality, sustainability and management than in the Great Lakes region. With nearly 9,500 miles of shoreline, the Great Lakes are aquatic systems dominated by their coastal watersheds.

National Goals

- Develop a quantitative understanding of the structure and function of critical nearshore habitats and coastal ecosystems.
- Identify the processes that control the transport, transformation and fate of biogeochemically important materials in the nearshore area, the impact of riverine inflows, and the influence of watershed management on coastal and estuarine systems.

Wisconsin Priorities

- Integrate watershed- and land-based information from Great Lakes observing systems to improve our understanding of the physical, chemical, biological and geological coupling at the land-water interface. (Digital Great Lakes/Geospatial Technologies Theme)
- Develop technologies for better spatial and temporal characterization of nearshore environments and coastal ecosystem dynamics.
- Evaluate the significance of invertebrate species to planktonic and benthic food webs and the role of these organisms in the Great Lakes food web transfer of energy and contaminants.
- Create partnerships to improve and enhance spawning habitat and nursery grounds to optimize native species rehabilitation.
- Improve the design, function and assessment of coastal habitat rehabilitation and restoration projects.
- Develop an understanding of how shoreline and harbor structures affect nearshore habitat, aquatic species and water quality, and how aquatic species use this habitat and interact with these structures.
- Conduct research, outreach and education activities for deterring, eradicating and/or controlling invasive species, nuisance algae and aquatic toxins. (*Aquatic Invasive Species Theme*)
- Foster increased public understanding and appreciation for Great Lakes ecosystems and habitats.

Benchmarks & Expected Outcomes

Based on the updated strategic priorities in each national theme and institutional strategic plan, we have identified the following benchmarks regarding the expected outcomes of implementing our strategic plan within the context of NOAA Sea Grant and UW-Madison's strategic plans.

Theme Area Benchmarks

The following benchmarks will be used to measure progress in the most significant areas of Wisconsin Sea Grant activity in each national theme area:

Aquaculture

- Tools and technologies developed and transferred to users that significantly reduce the adverse effects of stress in aquacultured fish.
- Successful transfer and applications of Recirculating Aquaculture Systems, Intensive Aquaculture Technology and broodstock manipulation and development technologies.
- The number of new aquaculture enterprises developed in the state and region.
- Increasing amounts of aquacultured yellow perch and walleye among the seafood consumed in Wisconsin.

Aquatic Invasive Species

- Development of a model to quantitatively predict zebra mussel impacts on the relationship between primary producers and higher trophic level organisms in Lake Michigan.
- Development of a model that explains the causes of the expansion of monotypic cattail stands and predicts the degree to which species-rich native sedge meadows can recover passively or need to be actively restored.

Biotechnology

• The adoption by the World Health Organization of 30 or more relative toxic equivalency factors for risk assessments of chlorinated aromatic hydrocarbons.

Coastal Communities & Economies

• The number of counties that adopt and use geographic information systems for "smart growth" planning in Wisconsin coastal watersheds.

Coastal Natural Hazards

• The development, transfer and application of geographic information systems for assessing, predicting and reducing natural coastal hazard risks.

Digital Ocean-Great Lakes Geospatial Technologies

• Digital spatial data assimilated from multiple distributed online sources, enabling remote access and real-time integration of these data by multiple users for specific applications.

Ecosystems & Habitats

• The design and assessment of a coastal habitat rehabilitation and restoration project.

Fisheries

• The adoption and use of the *Fish Identification and Bioenergetics Model* by at least 100 educators and fisheries managers.

Marine & Aquatic Science Literacy

• The doubling of cost-recoveries from sales of UW Sea Grant products to \$50,000 annually, along with a tripling in the amount of Sea Grant information products distributed to more than 55,000 items annually.

Seafood Science & Technology

• The returns on investment resulting from successful development of a new commercial fishery for siscowet (fat trout) on Lake Superior.

Urban Coast

- Identification of the sources and effects of PBDEs, mercury and other trace contaminants in the Great Lakes.
- The transfer and application of information regarding the sources, transport mechanisms and fate
 of bacterial and viral contamination responsible for beach closings to 10 Lake Michigan beach
 managers.
- Identification of the causes of accelerated corrosion of Great Lakes harbor facilities and the dissemination of this information to all port, harbor and marina operators in the region.

Innovative Science & Technology

- A reduction in the incidence of decompression sickness and dysbaric osteonecrosis in Puerto Rican seafood divers, as documented by follow-up research.
- More than 800 scientists meet in Madison, Wisconsin, and reach consensus on a policy-relevant conference declaration of the present state of scientific knowledge regarding the atmospheric sources, public health risks and societal consequences of global mercury pollution.

Institutional Benchmarks

Promote Research

- State-of-the-art research project management and reporting software developed and implemented.
- The number of promising new investigators brought into the UW Sea Grant research program.
- The amount of supplemental grants and other funding obtained by program staff and PIs.
- The number of peer-reviewed journal articles resulting from UW Sea Grant-supported projects.
- The number of professional presentations, publications, patents, articles, websites and radio programs resulting from Sea Grant-funded research, outreach and education.
- Documented acceptance and use by peers of new methods, approaches, information and tools resulting from UW Sea Grant-supported work.
- Long-range information technology strategies developed.

Advance Learning

- The number of students supported financially on Sea Grant projects.
- The number of Sea Grant-supported students successfully completing their Master's and doctorate degrees.

Accelerate Internationalization

• The number of international partnerships developed in research, outreach and education.